Modbus Utility User Manual

April 2014

Version 1.0.2

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1. Introduction

1.1 Instruction to the User Manual

Modbus is a very popular protocol used in the industrial manufacturing and environment monitoring fields. The Modbus Utility provided by ICP DAS can be used to communicate with the Host controller to retrieve data from remote modules. This manual describes how to use the Modbus Utility in conjunction with controllers that support the Modbus protocol. Also included are instructions for linking SCADA (Supervisor Control and Data Acquisition) software Modbus devices .

This manual applies to following controllers and modules.

<table>
<tr><th>Model</th><th>I/O Slots</th><th>CPU</th><th>SRAM</th><th>Flash</th><th>Memory Expansion</th><th>Ethernet</th><th>RS-232 /485</th></tr>
<tr><td>I-8431-MTCP</td><td>4</td><td rowspan="2">40 MHz</td><td rowspan="5">512 KB</td><td rowspan="7">512 KB</td><td rowspan="5">-</td><td rowspan="5">1 (10BASE-T)</td><td rowspan="3">3</td></tr>
<tr><td>I-8331-MTCP</td><td>8</td></tr>
<tr><td>I-8431-80-MTCP</td><td>4</td><td rowspan="5">80 MHz</td></tr>
<tr><td>I-8831-80-MTCP</td><td>8</td></tr>
<tr><td>I-8KE4-MTCP-G</td><td>4</td><td rowspan="2">1</td></tr>
<tr><td>I-8KE8-MTCP-G</td><td>8</td><td rowspan="3">768 KB</td></tr>
<tr><td>IP-8441-MTCP</td><td>4</td><td rowspan="2">Micro SD</td><td rowspan="3">2 (10/100 BASE-Tx)</td><td>4</td></tr>
<tr><td>IP-8841-MTCP</td><td>8</td></tr>
<tr><td>ET-87P4-MTCP</td><td>4</td><td rowspan="2">-</td><td rowspan="2">-</td><td rowspan="2">-</td><td rowspan="2">-</td><td rowspan="2">1</td></tr>
<tr><td>ET-87P8-MTCP</td><td>8</td></tr>
<tr><td>I-7188EX(D)-MTCP</td><td>-</td><td rowspan="3">40 MHz</td><td>512 KB</td><td rowspan="3">512 KB</td><td>-</td><td rowspan="2">1 (10BASE-T)</td><td rowspan="3">2</td></tr>
<tr><td>I-7188E2(D)-MTCP</td><td>-</td><td>384 KB</td><td>-</td></tr>
<tr><td>µPAC-7186EX(D)-MTCP</td><td>-</td><td>80 MHz</td><td>512 KB</td><td>-</td><td>1 (10/100 BASE-Tx)</td></tr>
</table>

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1.2 Modbus Protocol

1.2.1. What is the Modbus protocol?

Modbus is a communication protocol originally developed for Modicon controllers by Modicon Inc. in 1979. Modbus is a standard, truly open protocol and is the most widely used network communication protocol in industrial automation field. SCADA (Supervisor Control and Data Acquisition) and HMI (Human-Machine Interface) software can be used to easily integrate serial devices via the Modbus protocol.

1.2.2. What is the Modbus/TCP protocol?

The Modbus/TCP protocol is a variant of original Modbus protocol that was developed in 1999 to allow access to Ethernet devices by the Internet community.

1.2.3. What software supports the Modbus and Modbus/TCP protocol?

Most SCADA and HMI software packages include support for the Modbus protocol. For example: ControlMaestro, DASYLab, EZ Data Logger, GENESIS 32/64, iFIX, InduSoft Web Studio, LabView, Trace Mode, Vijeo Citect, Wonderware Intouch, etc.

1.2.4. What are the benefits of using Modbus and Modbus/TCP?

A. Open source, no license fees.
B. Widely supported by SCADA and HMI software
C. Easy to use
D. Easily integrated with a variety of devices
E. Low development cost
F. Wide knowledge base

1.2.5. Modbus Resources

A. http://www.modbus.org
   A community for Modbus users.
B. http://www.modbustools.com/modbus_activex.asp
   An ActiveX control to communicate with a Modbus slave device via Modbus (RTU/ASCII) or Modbus/TCP.

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1.3 Default Firmware Features

When purchased, the IP-8000-MTCP/I-8000-MTCP controller, already has the default Modbus firmware in Flash memory, and includes the following features.

1.3.1. Support for the Modbus/TCP communication protocol that allows access to I/O devices that are inserted in the I/O slots.

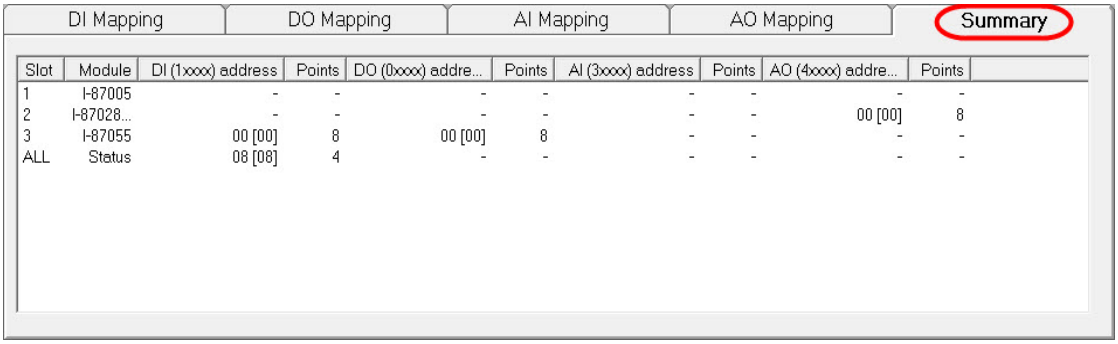
The default firmware allows user to connect to the controller by Ethernet, and send Modbus commands in Modbus/TCP protocol form.

1.3.2. Support for the VxComm technique for all COM ports on connected controllers.

Even if a serial device doesn't support the Modbus/RTU protocol, it can still be accessed via Ethernet. However, the VxComm driver will first need to be installed on the host PC and COM ports assigned in order to link to the controller's COM ports. Once installed, the serial clients will then be able to access these remote serial devices via Ethernet using the standard RS-232 functions. Here's the link of the VxComm driver for PC.
http://ftp.icpdas.com/pub/cd/8000cd/napdos/driver/vxcomm_driver/2k/

1.3.3. Automatic I/O module scanning.

When a connection created, the default firmware will scan all slots and then put modules information into the "Summary" table.


DI Mapping
DO Mapping
AI Mapping
AO Mapping
Summary
Slot Module DI (1xxxx) address Points DO (0xxxx) addre... Points AI (3xxxx) address Points AO (4xxxx) addre... Points
1 I-87005 - - - - - - - -
2 I-87028... - - - - - - 00 [00] 8
3 I-87055 00 [00] 8 00 [00] 8 - - - -
ALL Status 08 [08] 4 - - - - - -

1.3.4. Automatic assignment of a register address for the I/O modules.

An I/O module can be inserted into any slot and the Modbus firmware will automatically scan all slots and assign the I/O channels to register in a continuous range. The register mapping for all the I/O channels can be retrieved by connecting to the controller using the Modbus Utility.

1.3.5. Allows simultaneous access by multiple clients (or masters).

Different controllers support a different number of connections to a client. For more details, refer to the FAQ on ICPDAS web site.

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http://www.icpdas.com/faq/7188e/hardware/003.htm

1.3.6. *Online configuration via Ethernet using the Modbus Utility*

1.3.7. *Supports I-8000 and I-87000 series I/O modules*

1.3.8. *Updateable and programmable firmware*

The Modbus SDK provided by ICP DAS allows users to develop custom Modbus firmware. The link for IP-8000-MTCP shows as below.
http://ftp.icpdas.com/pub/cd/8000cd/napdos/modbus/ip8000/demo/bc/

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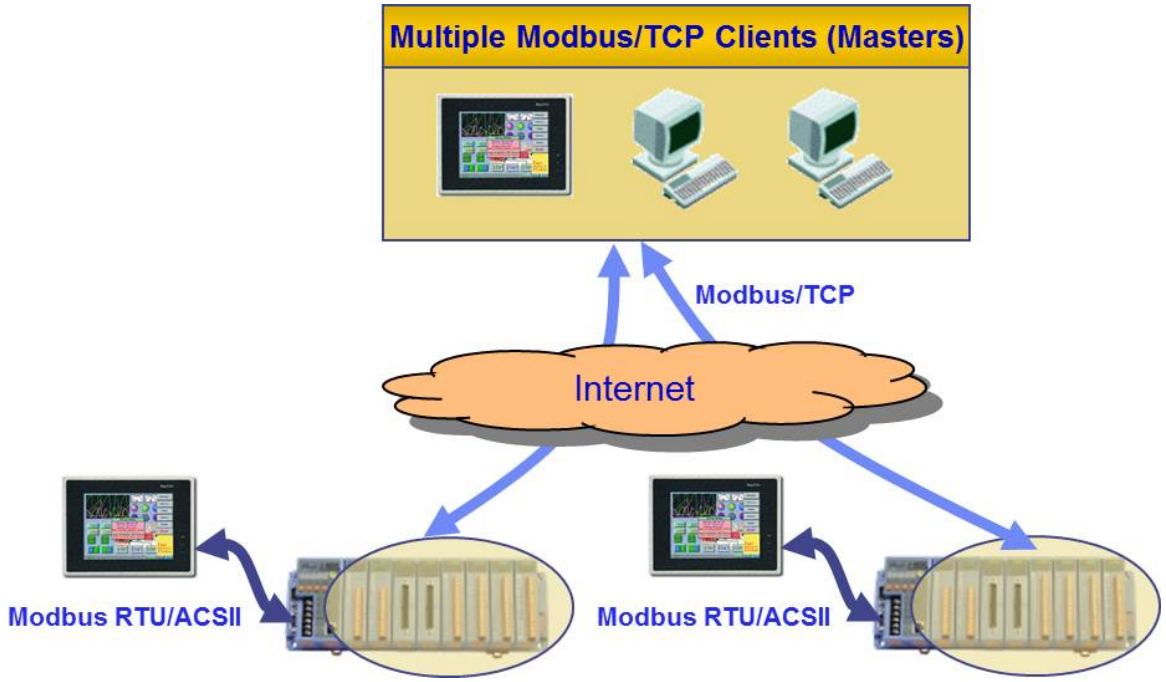
1.4 Typical Applications

1.4.1. Basic Application 1: Modbus TCP I/O Device

An I-8000-MTCP running the default firmware operates as a Modbus/TCP slave I/O device. Simply use the Modbus Utility to configure the device and then create a connection between the SCADA/HMI software and the I-8000-MTCP.



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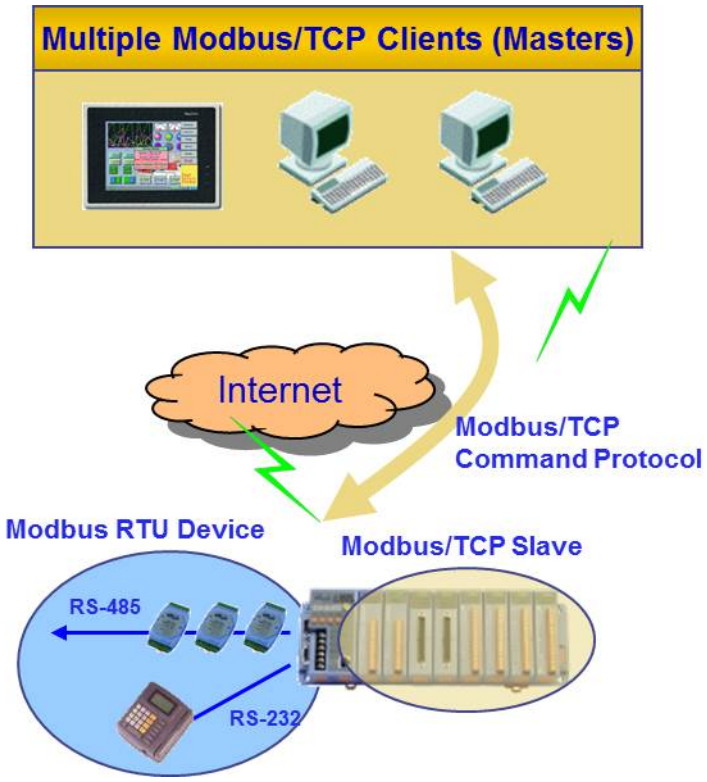
1.4.2. *Basic Application 2: Modbus/RTU to Modbus/TCP Converter*

After setting the COM Port to gateway mode via the Modbus Utility, the Modbus/RTU device can be linked to the I-8000-MTCP using the Modbus/TCP protocol. The SCADA/HMI software can then be configured to convert the Modbus/RTU device to a Modbus/TCP device.



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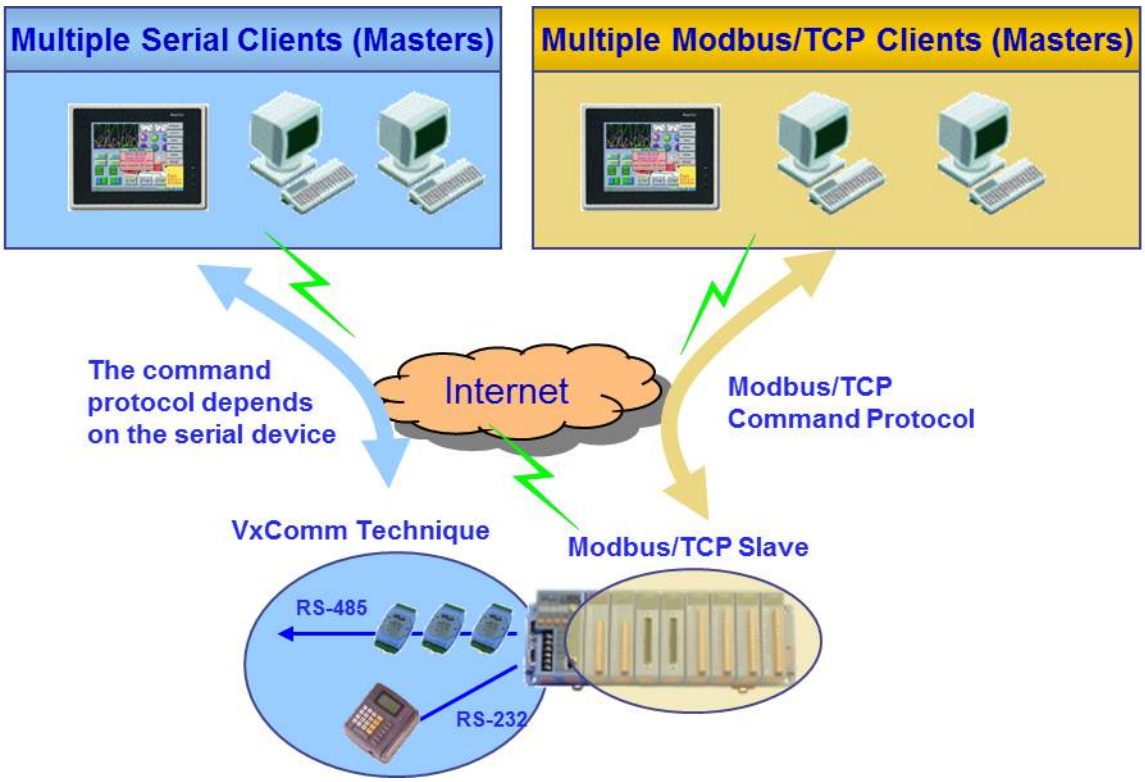
1.4.3. *Basic Application 3: Modbus/TCP I/O Device using the VxComm Technique*

An I-8000-MTCP is also able to link serial devices that are connected to the COM ports on the I-8000-MTCP device. To use this function, the VxComm driver first needs to be installed on the Host PC. After the driver is installed, the remote COM ports can be accessed via the standard serial driver.



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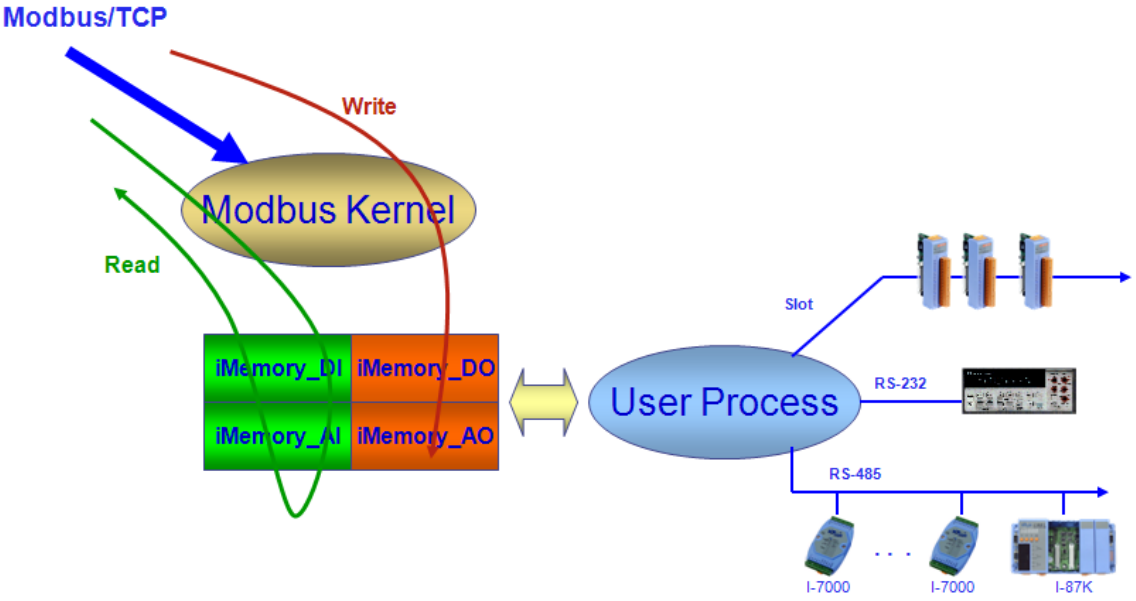
1.4.4. *Advanced Application 1: User-defined Modbus/TCP Controller*

Using the Modbus SDK, custom firmware can be developed that allows access to additional functions, together with integration of serial devices with Modbus/TCP kernel, making the I-8000-MTCP a powerful controller. The link for I-8000-MTCP shows as below.

http://ftp.icpdas.com/pub/cd/8000cd/napdos/modbus/8000e/demo/bc/

1.4.5. *Advanced Application 2: Modbus/TCP Controller using the VxComm technique*

If an I-8000-MTCP is used to link same hardware devices as described in Advanced Application 1 above, and if any of devices connected to specific COM ports are not integrated into the custom firmware, the COM ports can still be accessed using the standard serial driver. However, in order to do this, the VxComm driver must first be installed on the Host PC.



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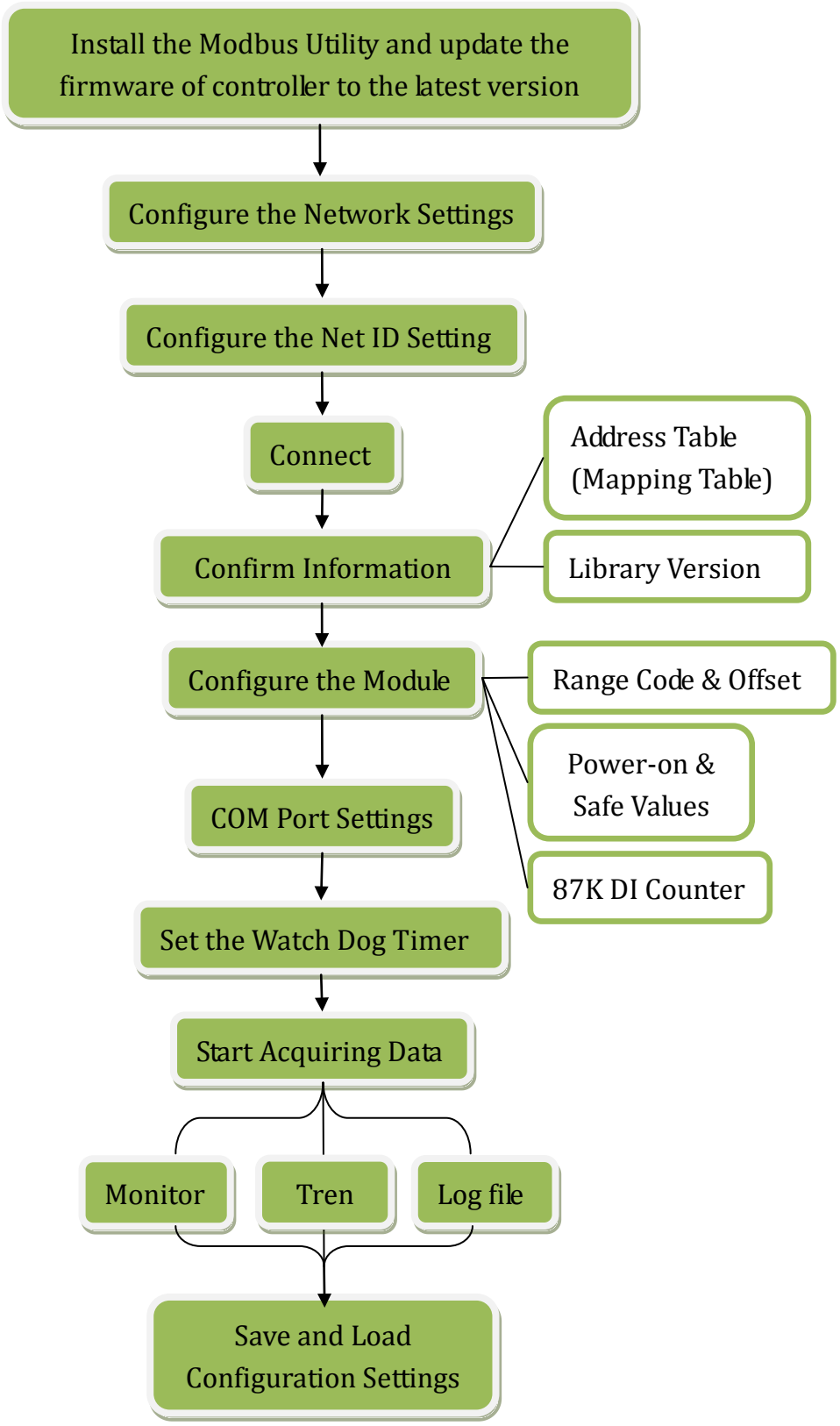
2. Starting the Modbus Utility

Follow the instructions described below to establish a connection between the controller and the Modbus Utility, then retrieve and set the I/O value.



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The Modbus Utility executable file can be downloaded from
http://ftp.icpdas.com/pub/cd/8000cd/napdos/modbus/modbus_utility/

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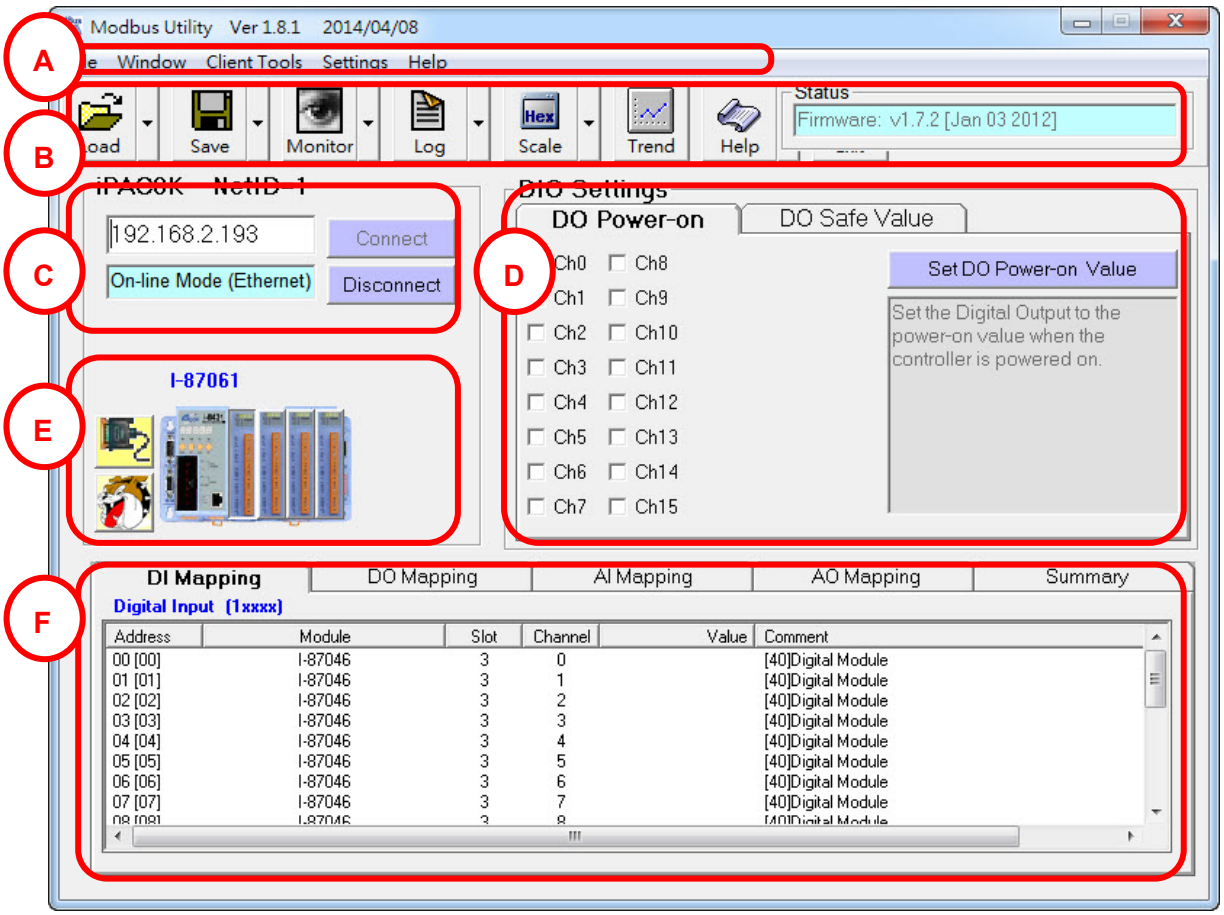
2.1 Instruction to the Working Area

The following is an illustration of the main working area of the Modbus Utility.



A. Menu Bar

B. Tool Bar

C. Connection panel

D. Power-on value, safe value ,offset and DI Counter settings panel

E. Controller Panel and Module Panel

   Left-hand side: COM ports and Watchdog Timer (WDT) settings

   Right-hand side: Module setting panel.

F. Address table (mapping table)

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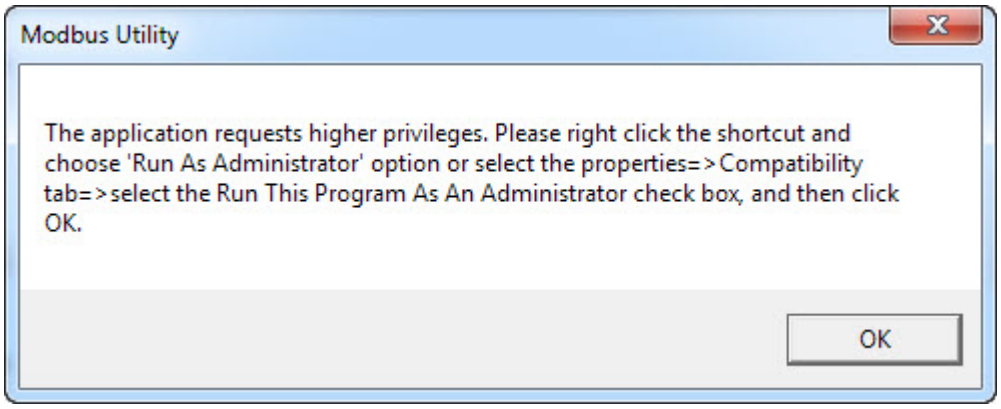
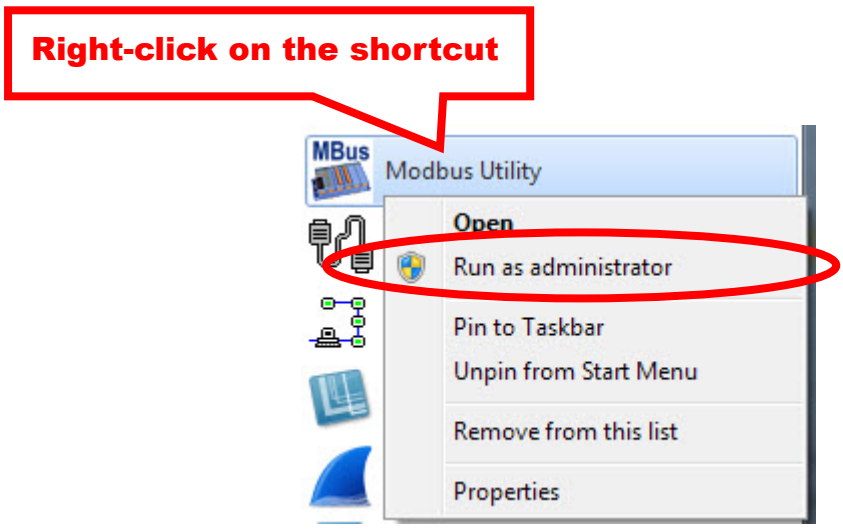
Note: If the warning message shown below is displayed after executing the Modbus Utility, reboot the program by right-clicking on the shortcut and clicking "Run As Administrator" to open the application with Administrator privileges.


Modbus Utility
The application requests higher privileges. Please right click the shortcut and choose 'Run As Administrator' option or select the properties=>Compatibility tab=>select the Run This Program As An Administrator check box, and then click OK.
OK



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2.2 Updating the Firmware

This function is used to update the firmware to the latest version. The firmware can be updated using either a COM port or a UDP connection. However, ensure that the LAN1 or COM1 ports are connected to the network or the computer before attempting to update the firmware.

2.2.1. Updating via the Ethernet

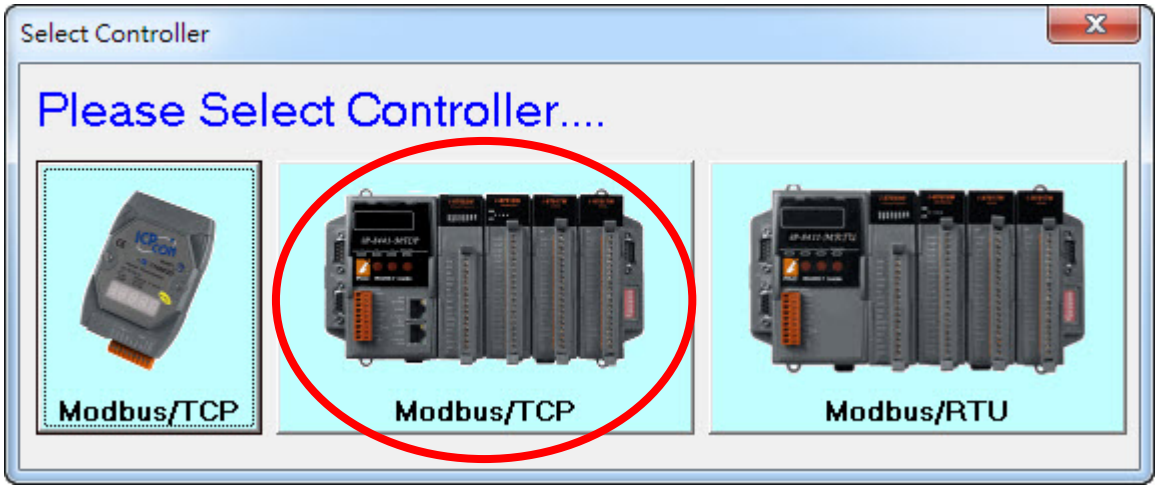
Step 1: Reboot the controller in INIT mode.

For I-8000 modules, short the INIT* and INIT*COM pins.

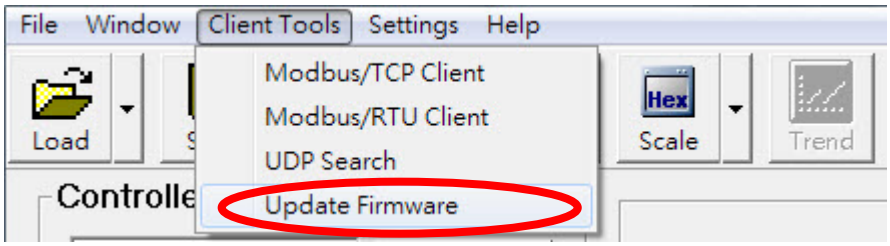
For IP-8000 and ET-87PN modules, move the DIP switch to the "Init" position.

For 7188E devices, short the INIT* and GND pins.

Step 2: Execute the Modbus Utility and select the Modbus/TCP mode.



Step 3: Select the "Update Firmware" option from the "Client Tools" menu to connect to the controller.



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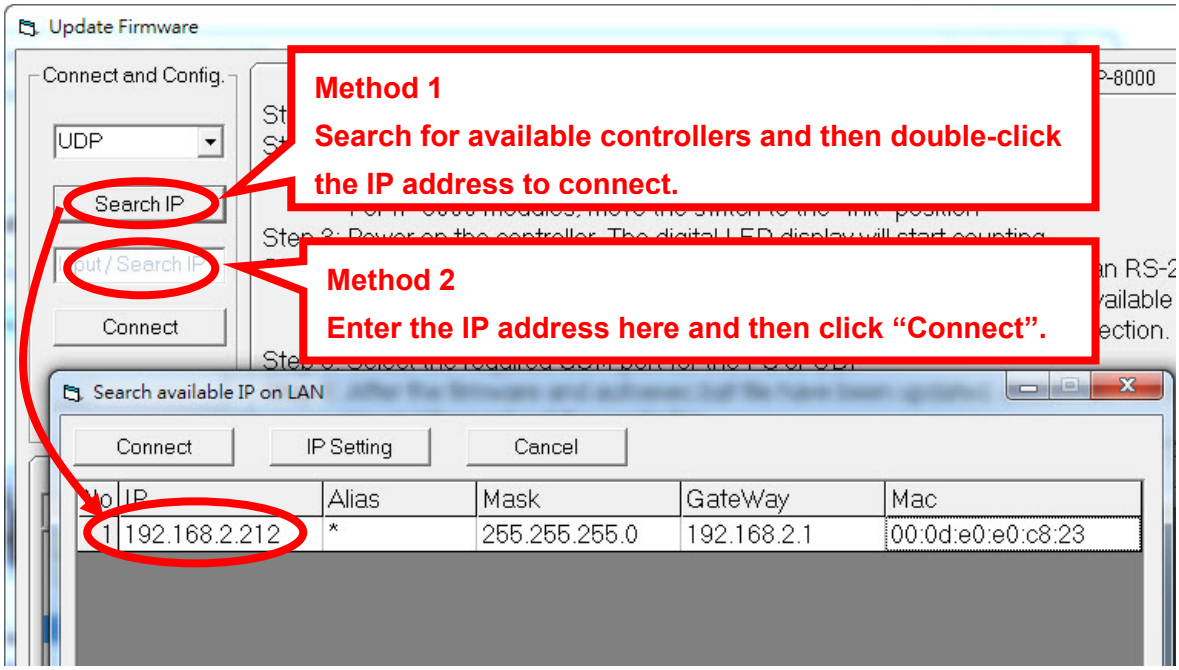
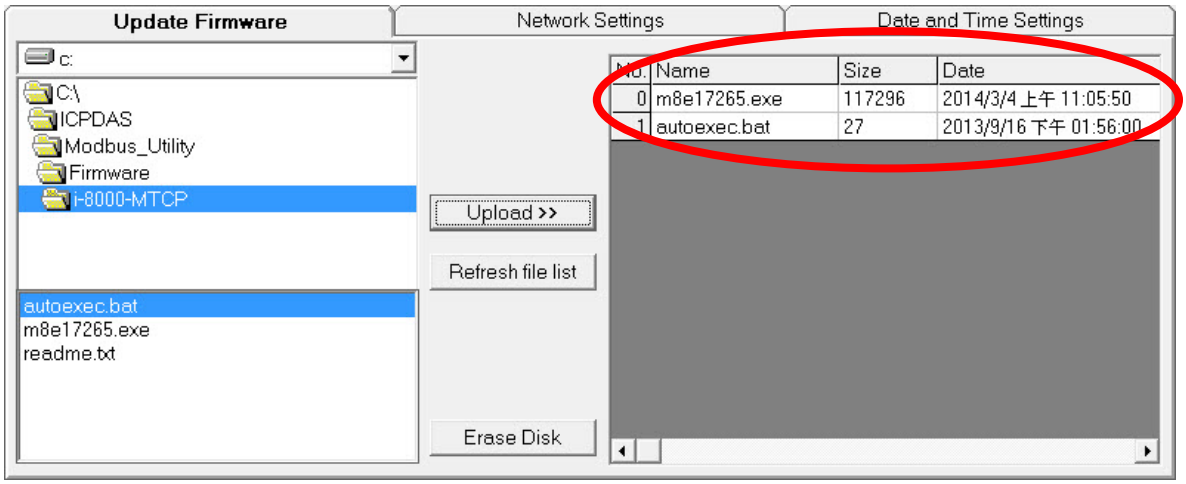
Select UDP option from the drop-down menu. If IP address is known, enter the details in the text field and then click the “Connect” button. Alternatively, click the “Search IP” button to search for available controllers on the LAN port and then double-click IP address to establish a connection.



After connecting, the firmware file for the controller will be listed in the “Update Firmware” tab, as shown in the diagram below.



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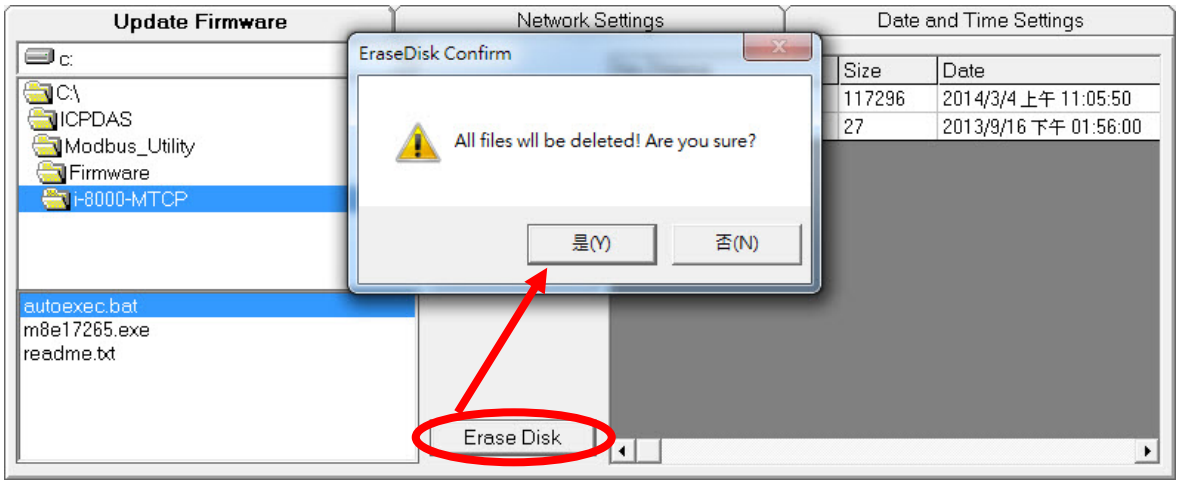
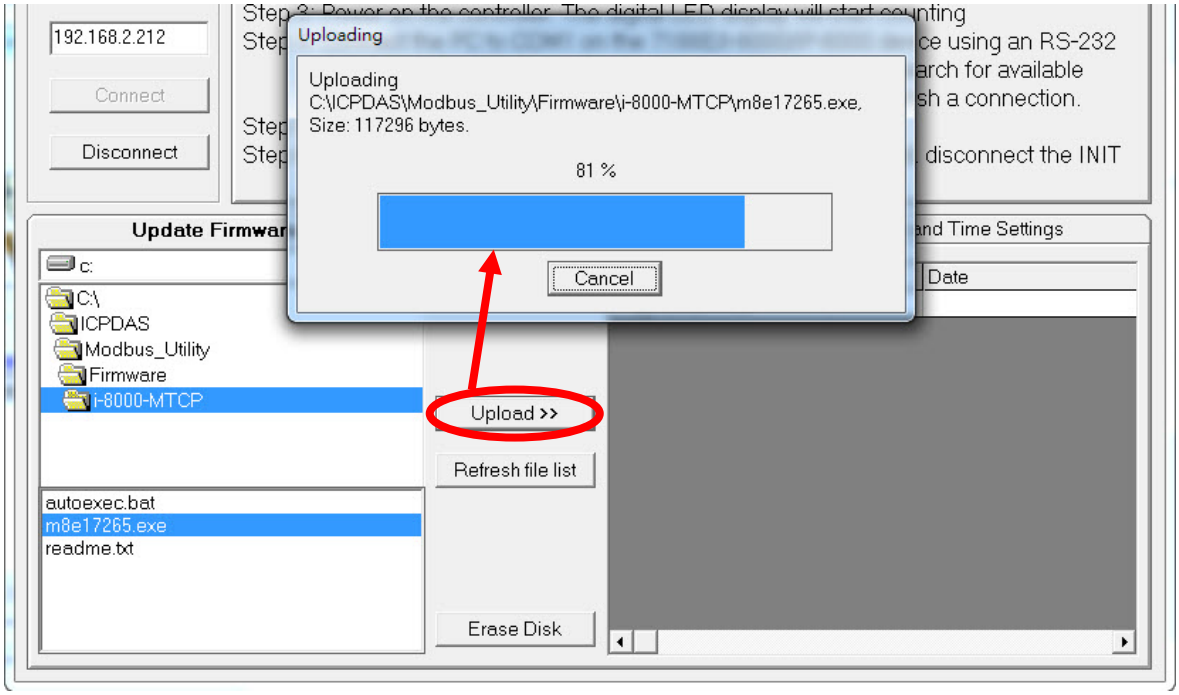
Step 4: Before updating the firmware, all existing files must be deleted. Click the "Erase Disk" button to delete all files currently existing on the controller.



Step 5: Select the new firmware file and then click the "Upload >>" button. After the update process is completed, the new file will be displayed in the file list. If it is not displayed, click the "Refresh file list" button to display the latest files.



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2.2.2. Updating via a Serial Port

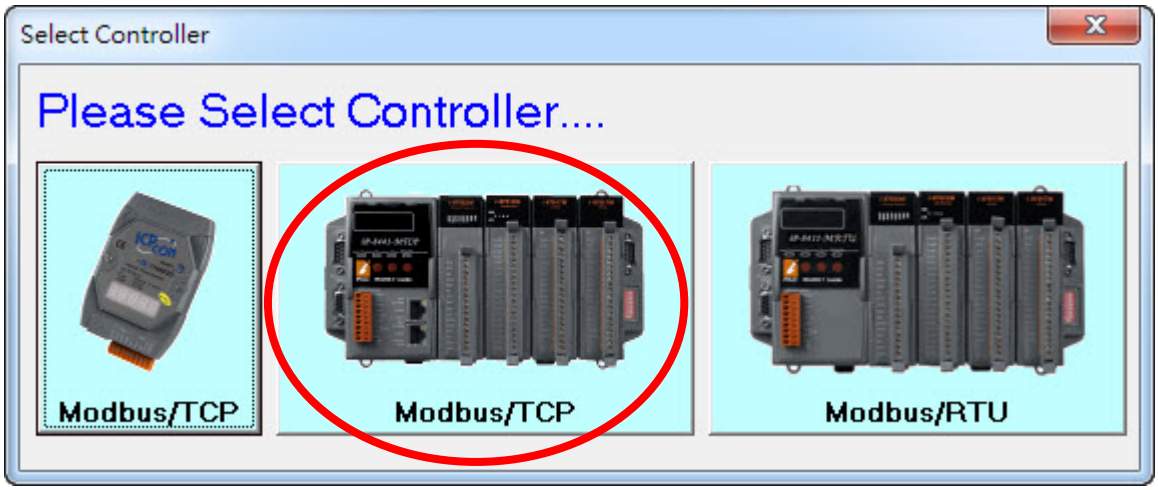
Step 1: Reboot the controller in INIT mode.

For I-8000 modules, short the INIT* and INIT*COM pins.

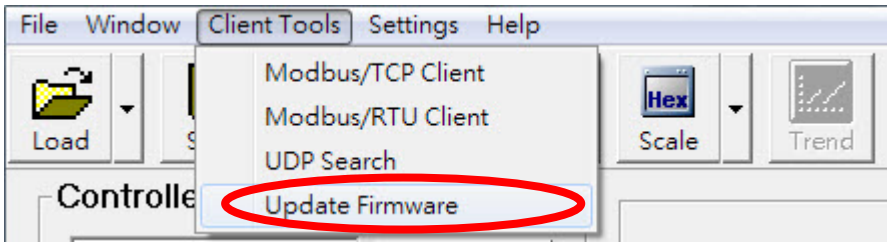
For IP-8000 and ET-87PN modules, move the DIP switch to the "Init" position.

For 7188E devices, short the INIT* and GND pins.

Step 2: Execute the Modbus Utility and select the Modbus/TCP mode.



Step 3: Select the "Update Firmware" option from the "Client Tools" menu to connect to the controller.



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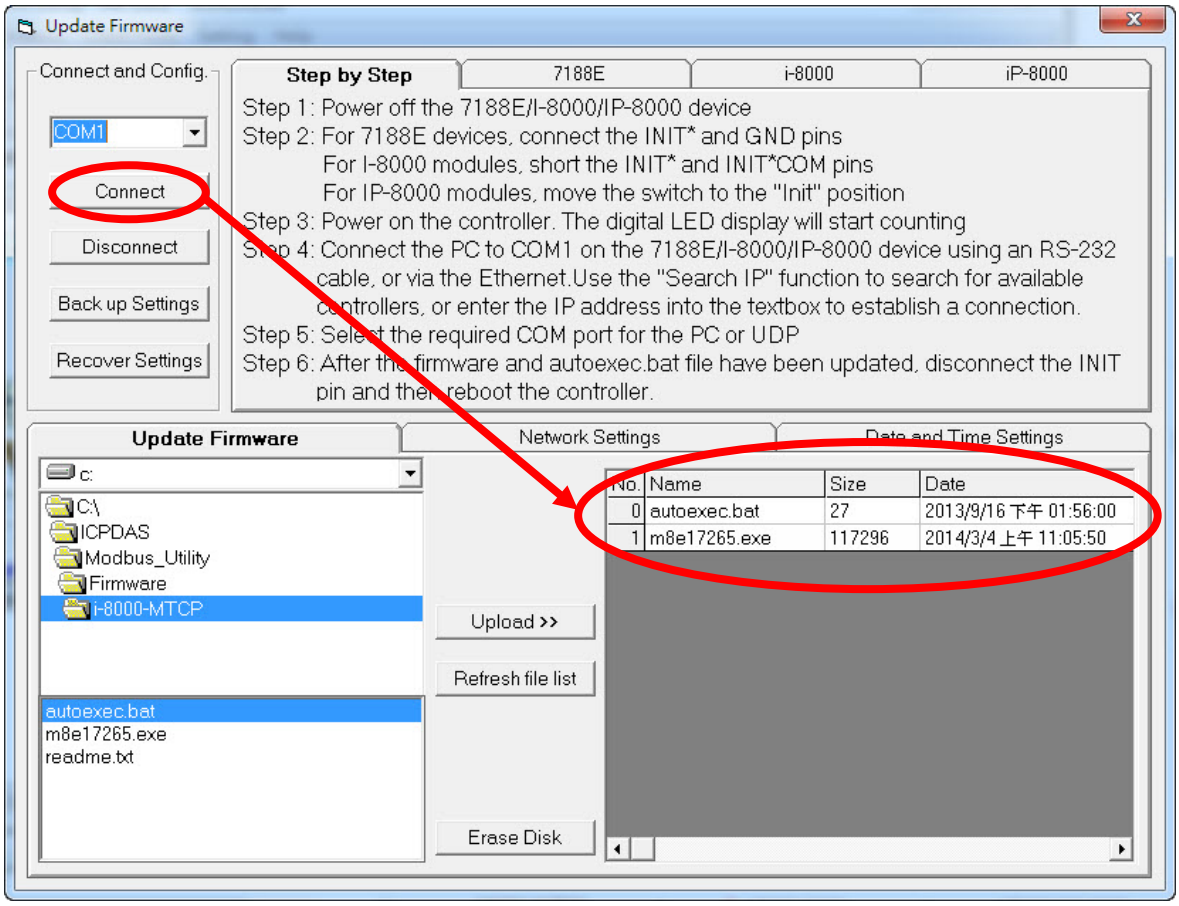
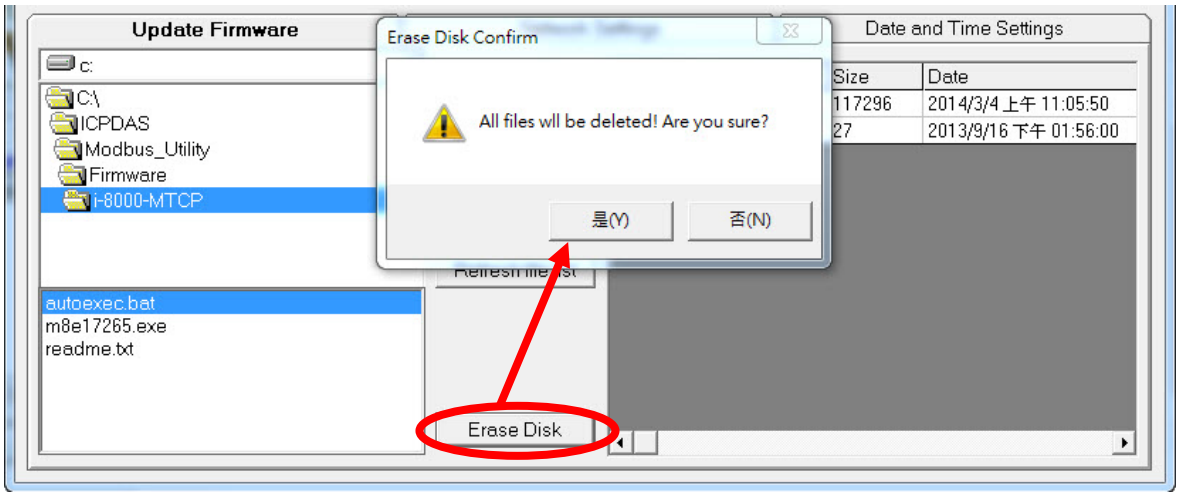
Select the required COM port from the drop-down menu and click the "Connect" button. After connecting, the firmware file for the controller will be listed in the "Update Firmware" tab, as shown in the diagram below.

Note: The default COM port settings are "115200, N, 8, 1".



Step 4: Before updating the firmware, all existing files must be deleted. Click the "Erase Disk" button to delete all files currently existing on the controller.



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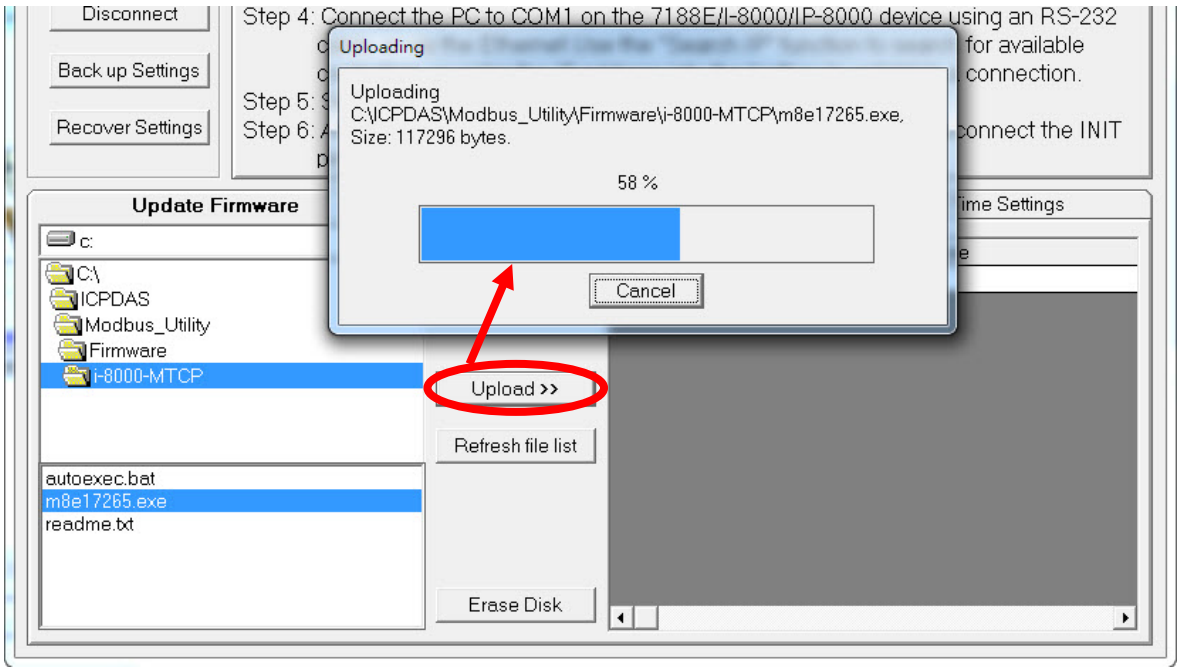
Step 5: Select the new firmware file and then click "Upload >>" button. After the update process is completed, the new file will be displayed in the file list. If it is not displayed, click the "Refresh file list" button to display the latest files.



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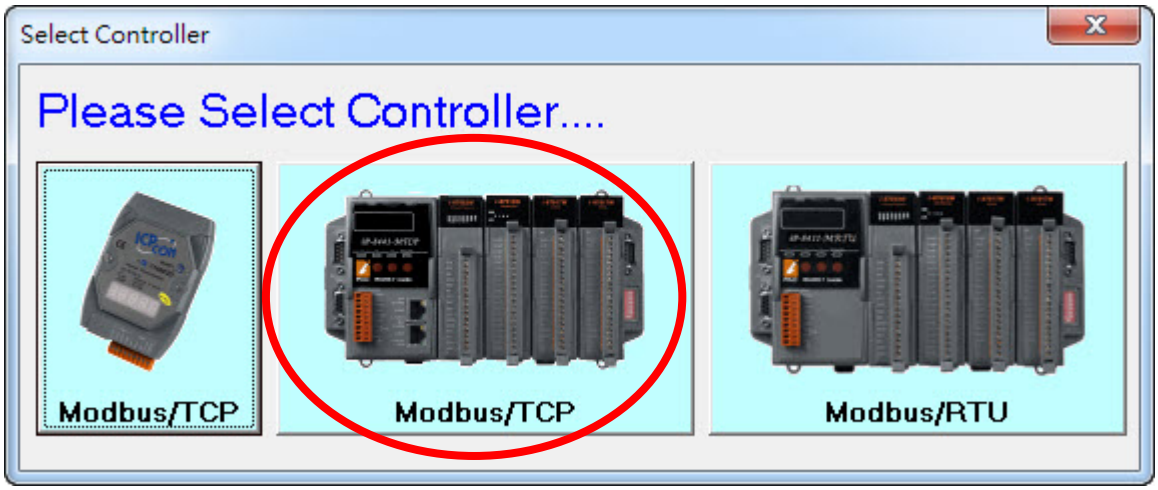
2.3 Network Settings

Before starting the configuration process, ensure that LAN1 or LAN2 are connected to your network. There are two methods of configuring the network using a UDP connection.

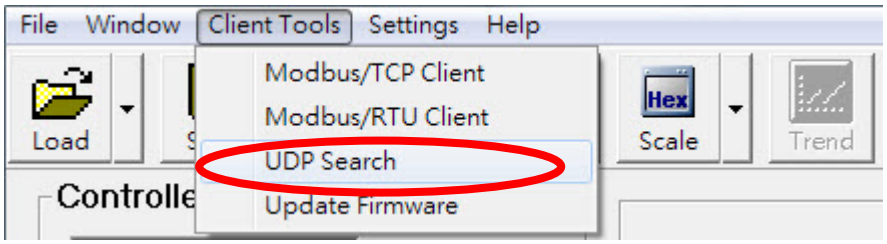
2.3.1. Method 1: Under Running Firmware Mode

Step 1: Make the controller under the running firmware mode.

Step 2: Execute the Modbus Utility and select the Modbus/TCP mode.



Step 3: Select the "UDP Search" option from the "Client Tools" menu to open the eSearch Utility.



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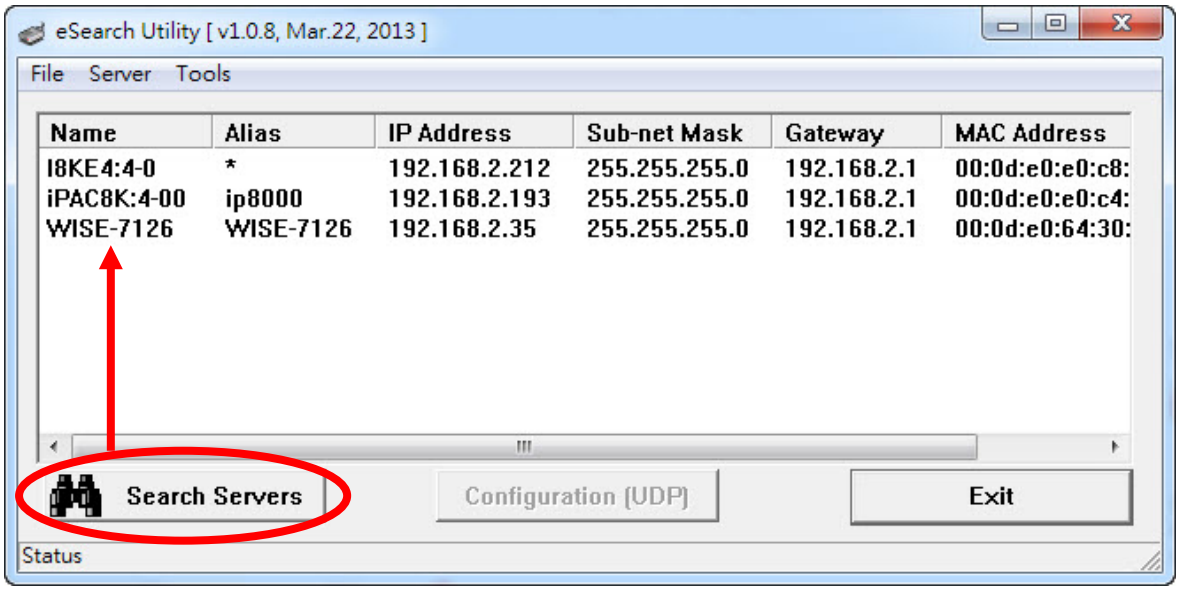
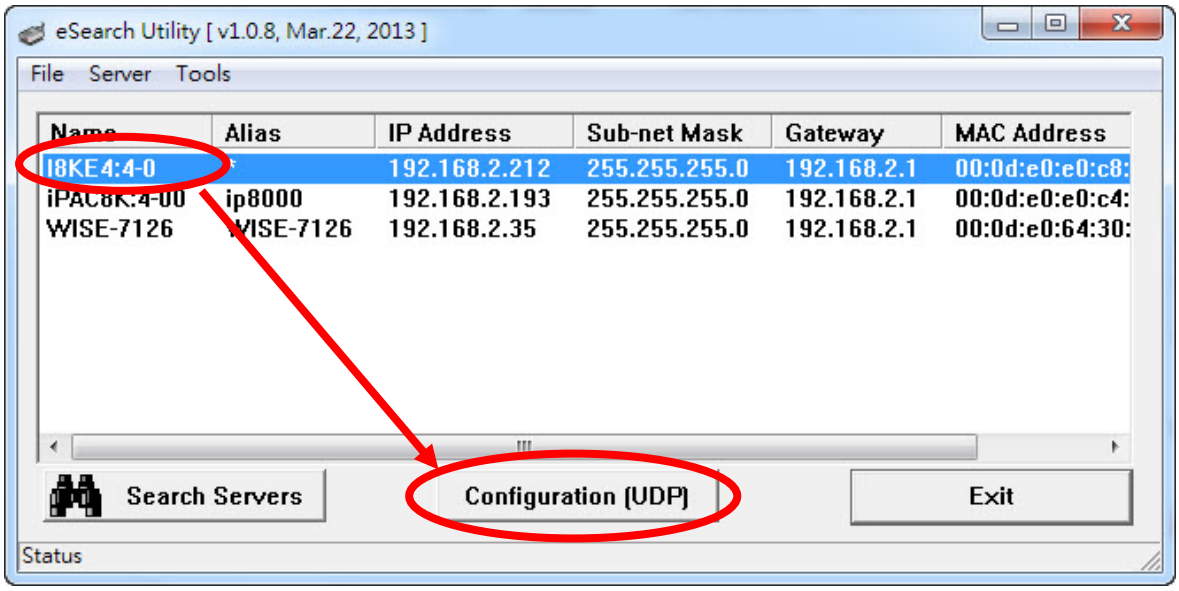
Step 4: Click the “Search Servers” button to search for the controllers on the LAN.


eSearch Utility [v1.0.8, Mar.22, 2013]
File Server Tools
Name Alias IP Address Sub-net Mask Gateway MAC Address
I8KE4:4-0 * 192.168.2.212 255.255.255.0 192.168.2.1 00:0d:e0:e0:c8:
iPAC8K:4-00 ip8000 192.168.2.193 255.255.255.0 192.168.2.1 00:0d:e0:e0:c4:
WISE-7126 WISE-7126 192.168.2.35 255.255.255.0 192.168.2.1 00:0d:e0:64:30:
Search Servers
Configuration (UDP)
Exit
Status

Step 5: Select the controller that is to be configured and then click the “Configuration (UDP)” button.


eSearch Utility [v1.0.8, Mar.22, 2013]
File Server Tools
Alias IP Address Sub-net Mask Gateway MAC Address
I8KE4:4-0 192.168.2.212 255.255.255.0 192.168.2.1 00:0d:e0:e0:c8:
iPAC8K:4-00 ip8000 192.168.2.193 255.255.255.0 192.168.2.1 00:0d:e0:e0:c4:
WISE-7126 WISE-7126 192.168.2.35 255.255.255.0 192.168.2.1 00:0d:e0:64:30:
Search Servers
Configuration (UDP)
Exit
Status

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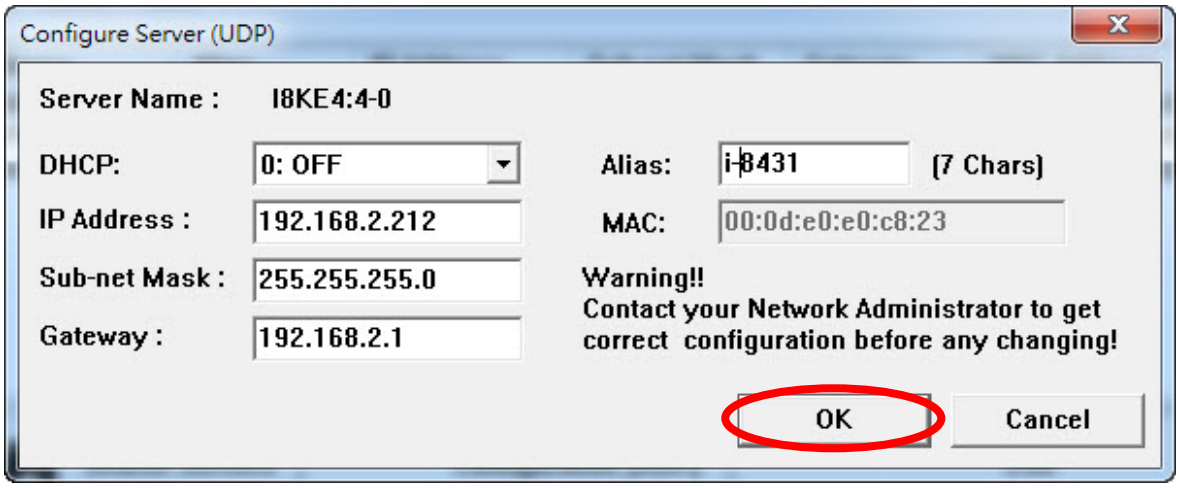
Enter the required details in the IP, Mask, Gateway, Alias and DHCP fields, and then click the “OK” button to save the settings.



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2.3.2. Method 2: Under Initial Mode

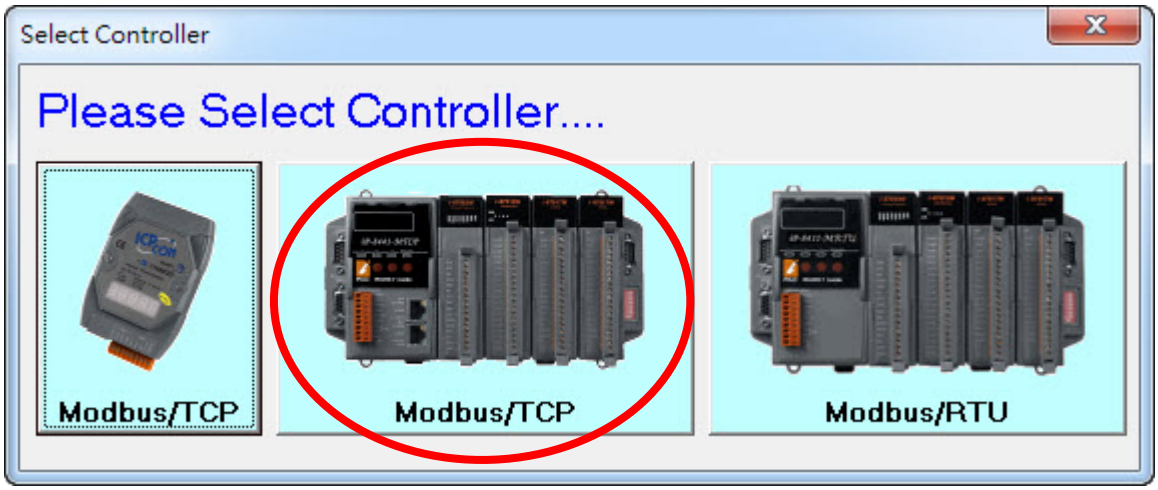
Step 1: Reboot the controller in INIT mode.

For I-8000 modules, short the INIT* and INIT*COM pins.

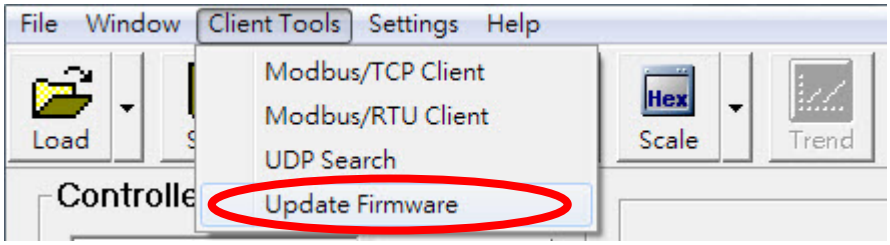
For IP-8000 and ET-87PN modules, move the DIP switch to the "Init" position.

For 7188E devices, short the INIT* and GND pins.

Step 2: Execute the Modbus Utility and select the Modbus/TCP mode.



Step 3: Select the "Update Firmware" option from the "Client tools" menu.



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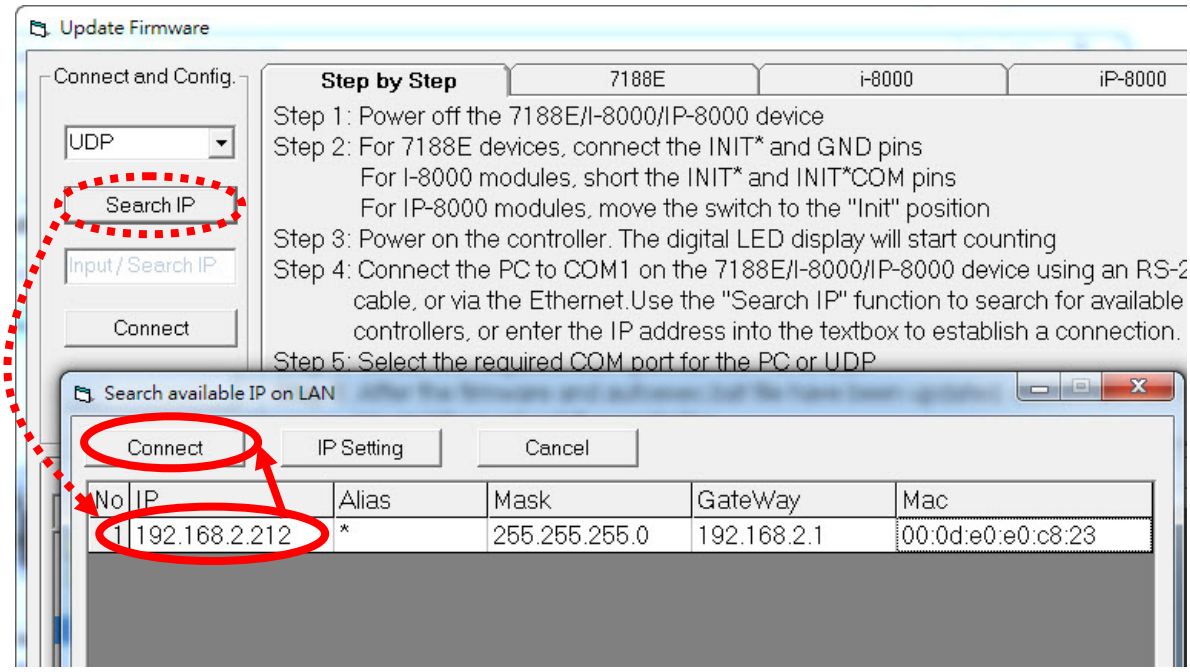
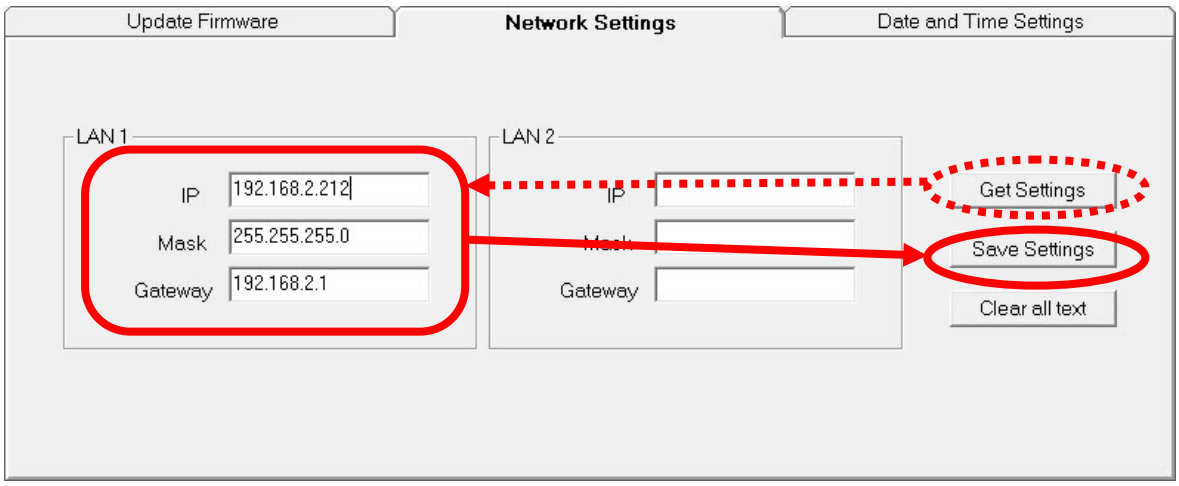
Step 4: Select the UDP option from the drop-down menu, and click the "Search IP" button to search for available controllers. When the search is completed, select an IP address and click the “Connect” button to establish a connection.


Update Firmware
Connect and Config.
UDP
Search IP
Input / Search IP
Connect
Step by Step
7188E
i-8000
iP-8000
Step 1: Power off the 7188E/I-8000/IP-8000 device
Step 2: For 7188E devices, connect the INIT* and GND pins
For I-8000 modules, short the INIT* and INIT*COM pins
For IP-8000 modules, move the switch to the "Init" position
Step 3: Power on the controller. The digital LED display will start counting
Step 4: Connect the PC to COM1 on the 7188E/I-8000/IP-8000 device using an RS-2
cable, or via the Ethernet.Use the "Search IP" function to search for available
controllers, or enter the IP address into the textbox to establish a connection.
Step 5: Select the required COM port for the PC or UDP
Search available IP on LAN
Connect
IP Setting
Cancel
No
IP
Alias
Mask
GateWay
Mac
1
192.168.2.212
*
255.255.255.0
192.168.2.1
00:0d:e0:e0:c8:23

Step 5: Select the “Network Settings” tab and then click the “Get Settings” button. The current network settings will be displayed in the LAN 1 text fields. Edit the settings as required and then click the "Save Settings" button to save the new settings.



After setting the new network, the Modus Utility will connect to new IP address automatically.

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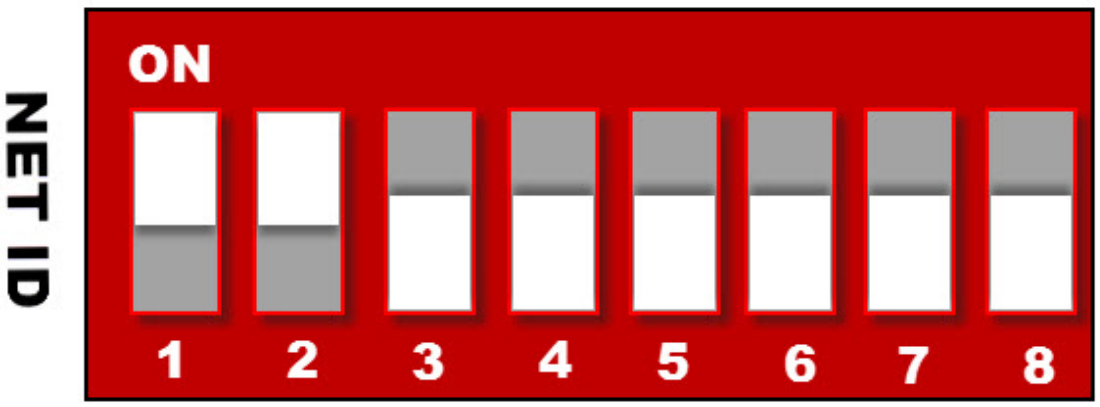
2.4 Net ID (Station number) Setting

The Net ID can be from 01 to FF and must be unique in the network. Set Net ID by following the procedure described below.

Step 1: The Net ID is set using the 8-bit DIP switch located on the right-hand side of the controller. To set the Net ID, move the DIP switch for the required bit to the ON position. The following figure shows the Net ID for the controller. Bits 1 and 2 are in the ON position and the others are set to OFF, meaning that the Net ID for the controller is 3.



Step 2: Reboot the controller to set the new Net ID

Step 3: After connecting to the controller, the Net ID for the controller will be displayed in the connection panel as described in Instruction to the Working Area index C.

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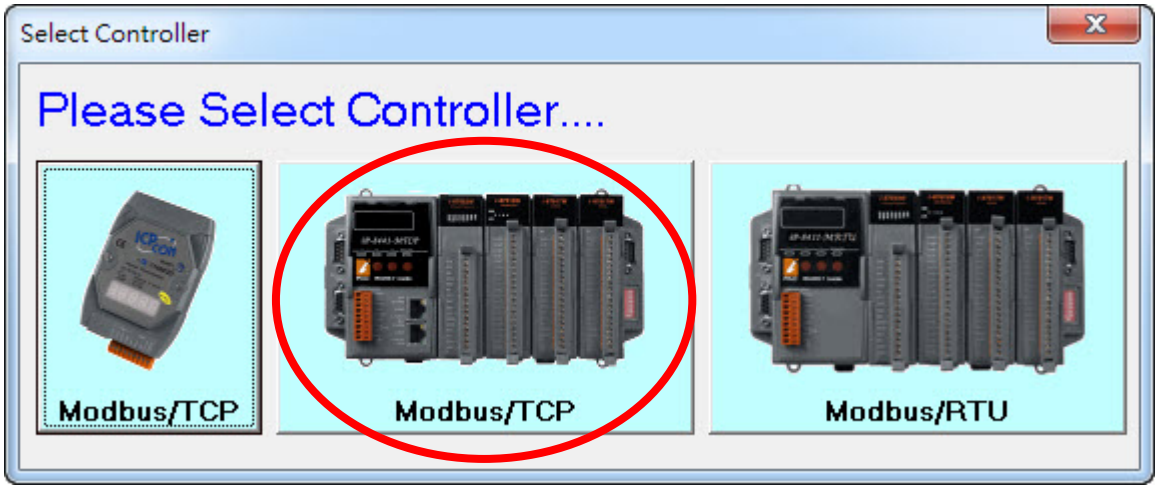
2.5 Connecting to the Controller

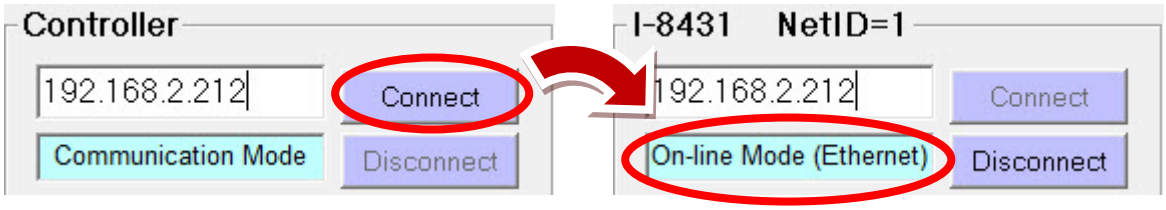
Before performing the following operation, set the controller to "Run Firmware" mode, insert the modules, and then turn on the power.

2.5.1. Connect via the Ethernet (Modbus/TCP)

Step 1: Execute the Modbus Utility and select the Modbus/TCP mode.



Step 2: Enter the IP address for your controller, and then click the "Connect" button. If a connection is successfully established, the status will be displayed in the text filed indicated in the diagram below.



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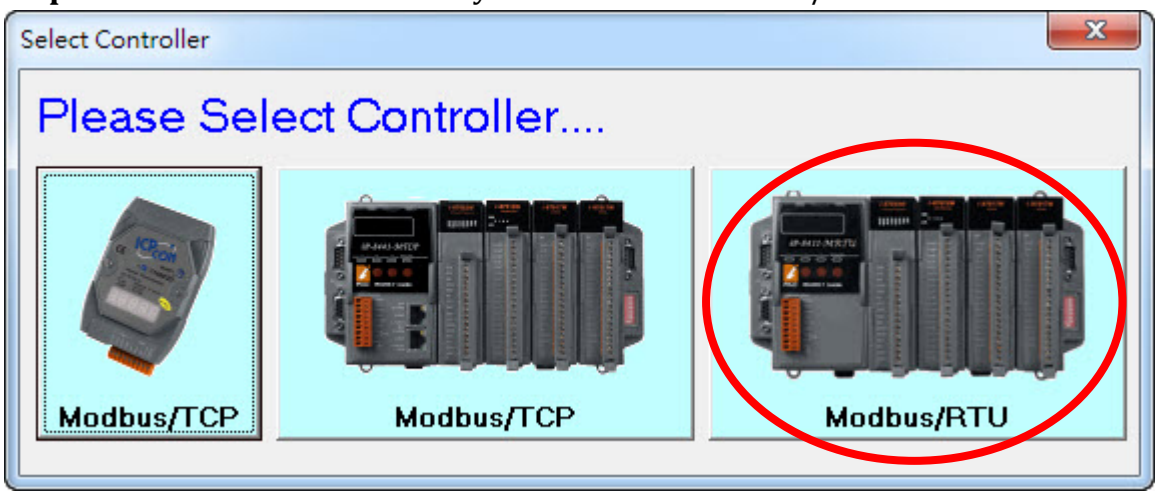
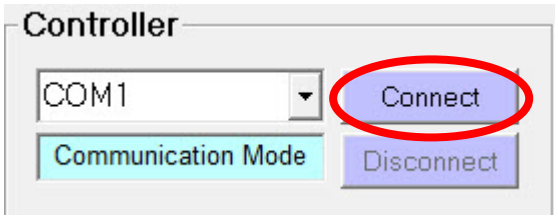
2.5.2. Connect via a Serial port (Modbus/RTU)

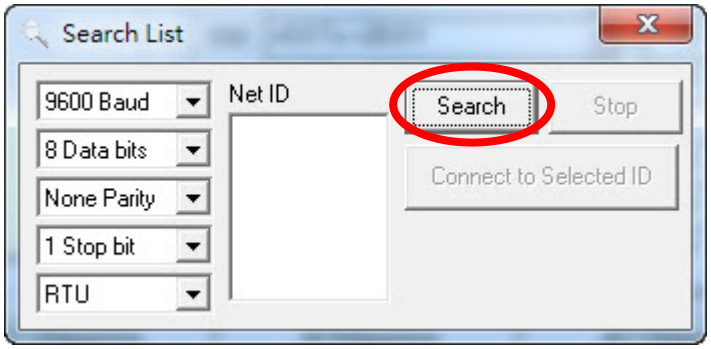
Step 1: Execute the Modbus Utility and select the Modbus/RTU mode.



Step 2: Select the COM port and click "Connect" on the connect panel.



Step 3: Click the "Search" button to search for any available device. After locating the required device, click the "Stop" button to stop searching.



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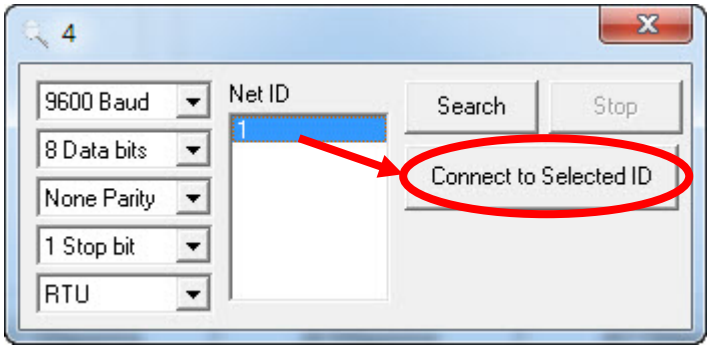
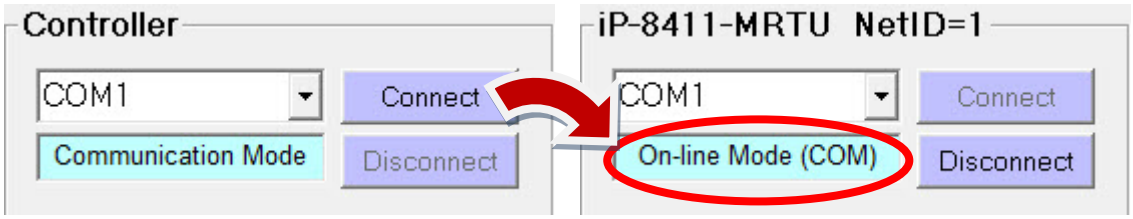
Step 4: Select the Net ID from the list, and then click the "Connect to selected ID" button to establish a connection.

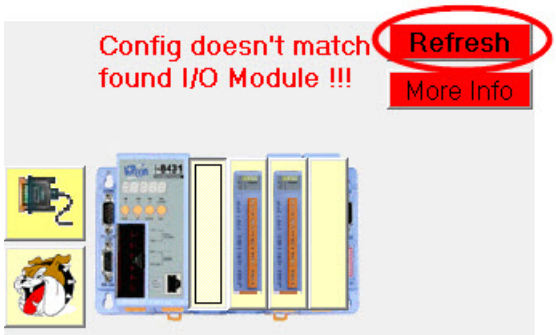


If COM port is successfully opened, the status will be displayed in the text filed indicated in the diagram below.



2.5.3. Refresh Configuration after Connecting

If the current configurations for the modules on the controller do not match the setting stored in the EEPROM, click the "Refresh" button to save the current configuration to the EEPROM.



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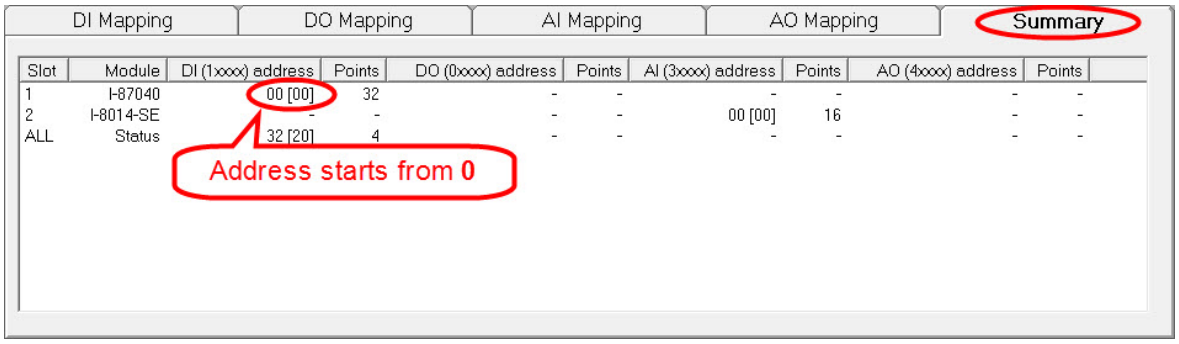
2.6 Address Table (Mapping Table)

After connecting to the module, use the **Summary** tab on the address table to check the information related to the module, including the slot number for the module and address of the I/O channels (points).

Note: The I/O addresses here are Base 0.



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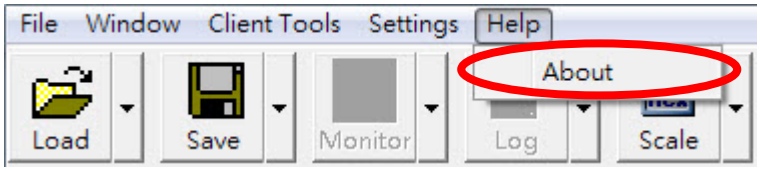
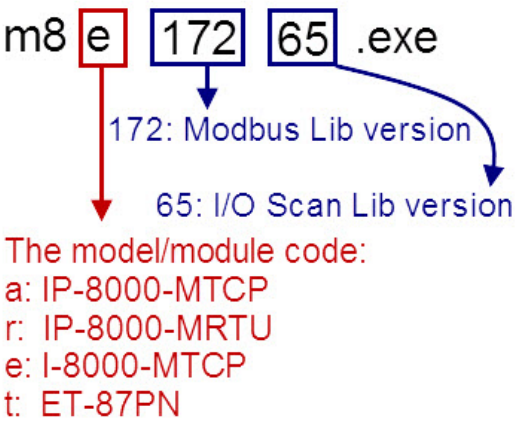
2.7 Library Version

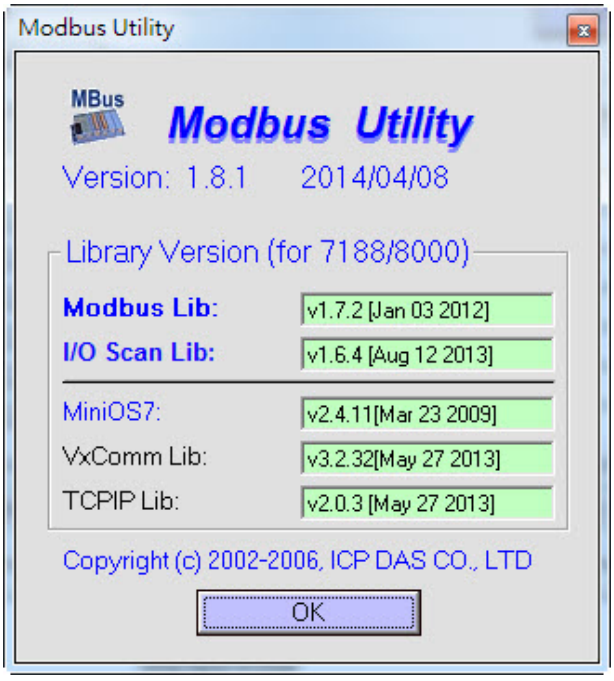
The version of the library depends on the version of the firmware. The latest version of the firmware can be obtained from the following addresses.
For 7188E:
http://ftp.icpdas.com/pub/cd/8000cd/napdos/modbus/7188e/firmware/
For ET-87PN:
http://ftp.icpdas.com/pub/cd/8000cd/napdos/modbus/et87pn/firmware/
For I-8000-MTCP:
http://ftp.icpdas.com/pub/cd/8000cd/napdos/modbus/8000e/firmware/
For IP-8000-MTCP:
http://ftp.icpdas.com/pub/cd/8000cd/napdos/modbus/ip8000/firmware/
Check the version information for the library using the following procedure:

Step 1: Select the "About" option from the "Help" menu.



Step 2: The version information will be displayed in the Modbus Utility "About" dialog box. The Modbus library and the I/O scan library are related to the firmware name. The format of the version information is as follows.




Modbus Utility
MBus
Modbus Utility
Version: 1.8.1 2014/04/08
Library Version (for 7188/8000)
Modbus Lib: v1.7.2 [Jan 03 2012]
I/O Scan Lib: v1.6.4 [Aug 12 2013]
MiniOS7: v2.4.11[Mar 23 2009]
VxComm Lib: v3.2.32[May 27 2013]
TCPIP Lib: v2.0.3 [May 27 2013]
Copyright (c) 2002-2006, ICP DAS CO., LTD
OK

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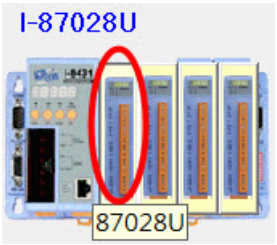
2.8 Range Code and Offset Settings

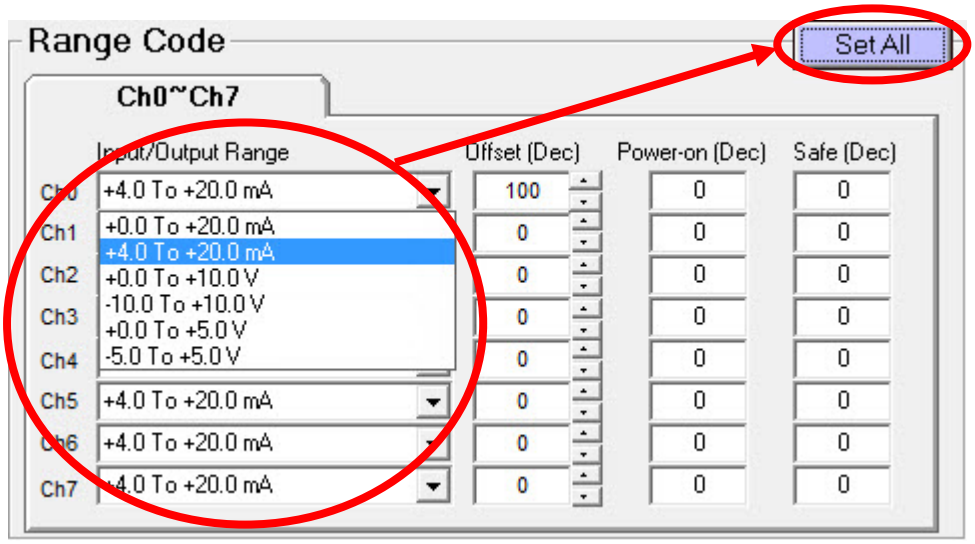
To change the range code and offset settings, click the module that is to be configured to open the Settings panel.



The image here shows the I-87028U module as an example.

2.8.1. Range Code

Range code is used to set the maximum and minimum input/output range for the module and only signals within this range can be legally transmitted.
Configure the Range Code setting in the Settings panel, and then click the “Set All” button to apply the new settings.



The range code types and definitions for modules are shown in Appendix D: Range Codes for Analog Modules.

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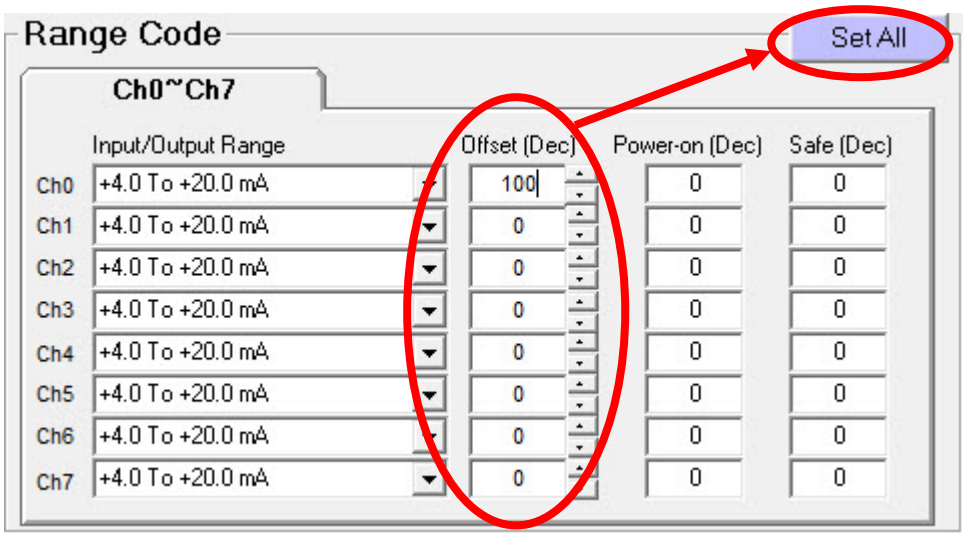
2.8.2. Offset Settings

An offset value can be set to compensate for any inaccuracies that exist in the module. Enter an offset value in the text field for the relevant channel, and then click the “Set All” button to apply the new settings


Range Code
Set All
Ch0~Ch7
Input/Output Range
Offset (Dec)
Power-on (Dec)
Safe (Dec)
Ch0 +4.0 To +20.0 mA 100 0 0
Ch1 +4.0 To +20.0 mA 0 0 0
Ch2 +4.0 To +20.0 mA 0 0 0
Ch3 +4.0 To +20.0 mA 0 0 0
Ch4 +4.0 To +20.0 mA 0 0 0
Ch5 +4.0 To +20.0 mA 0 0 0
Ch6 +4.0 To +20.0 mA 0 0 0
Ch7 +4.0 To +20.0 mA 0 0 0

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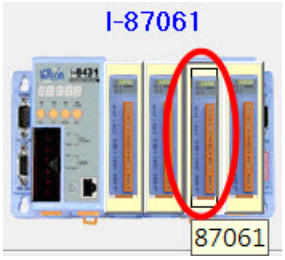
2.9 Digital Output Power-on and Safe Values

To change the Digital Output Power-on and Safe values, click the module that is to be configured to open the Settings panel.

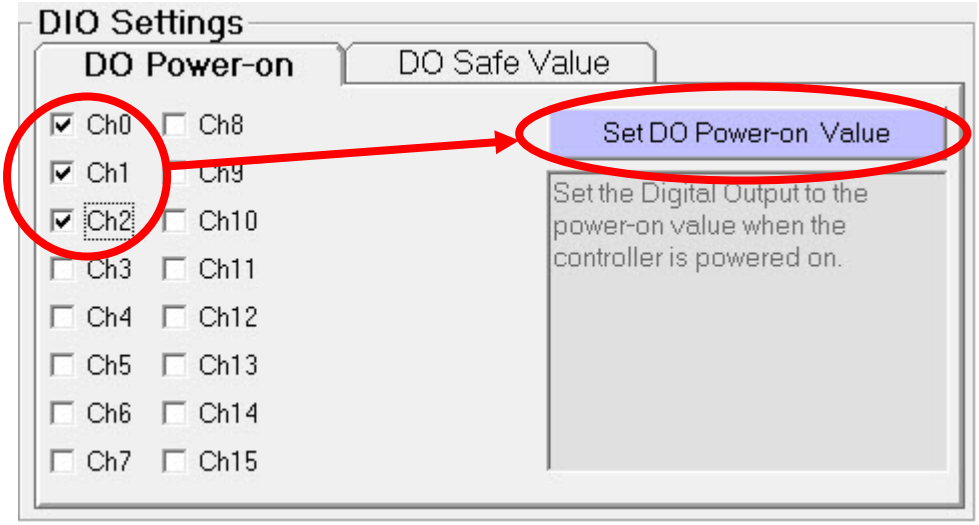


The image here shows the I-87061 module as an example.

2.9.1. Digital Output Power-on Value

The Power-on value is the Digital Output value that will be set for the module when the controller is powered on every time.

Step 1: In the "DO Power-on" tab of the DIO Settings dialog box, check the checkbox(es) for the channel(s) to be set, and then click the "Set DO Power-on Value" button to apply the Power-on value.



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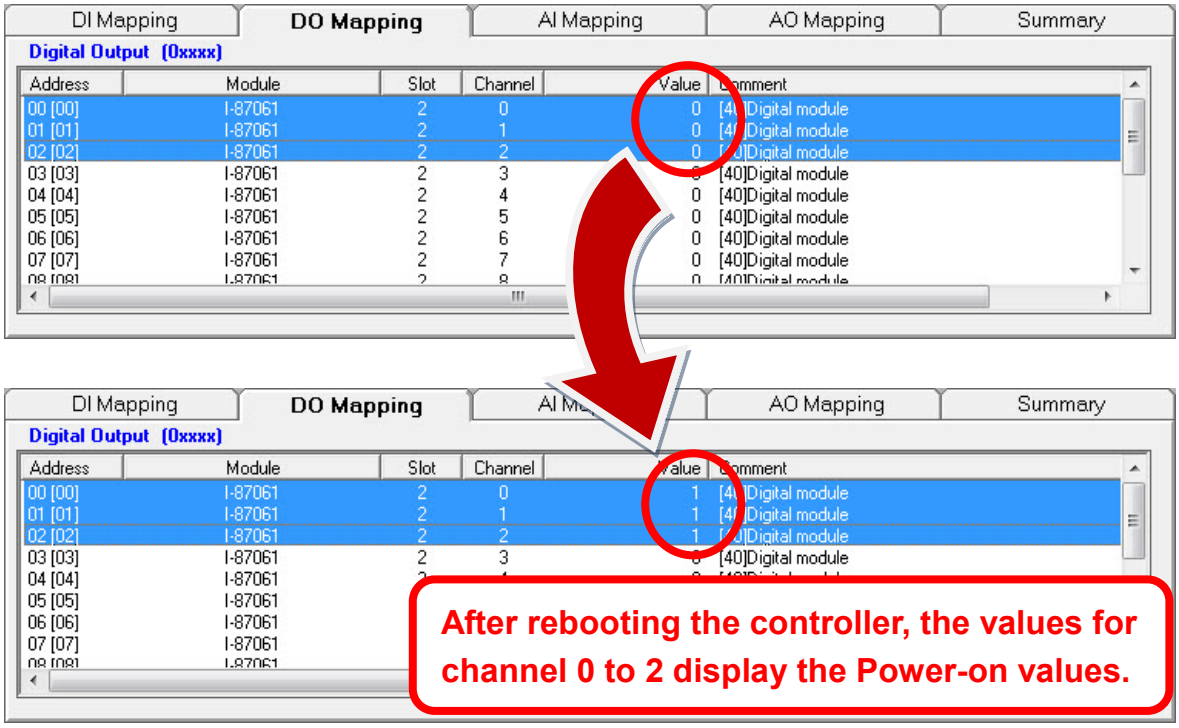
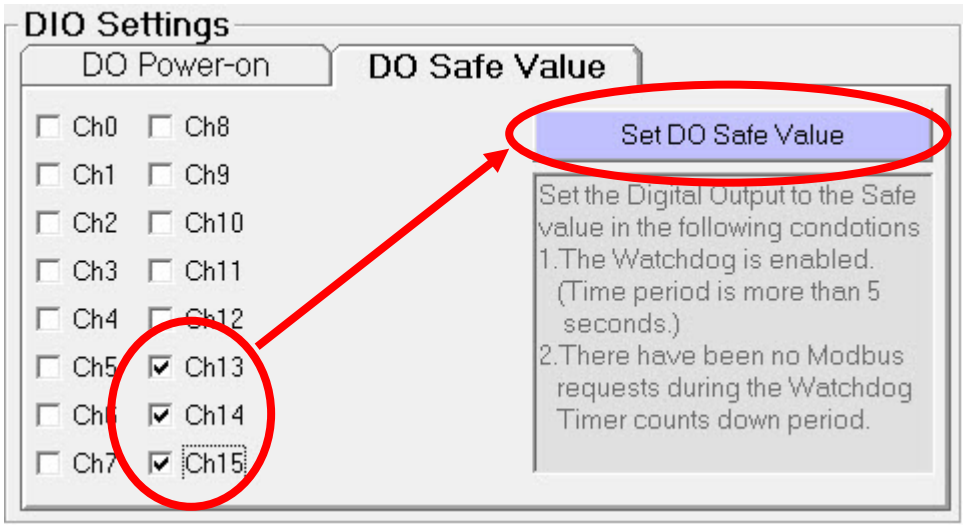
Step 2: The controller should be rebooted if the new Power-on settings would like to be applied. After rebooting, the Power-on value will be displayed in the DO Mapping tab in monitoring mode, or check the output LED.


DI Mapping
DO Mapping
AI Mapping
AO Mapping
Summary
Digital Output (0xxxx)
Address
Module
Slot
Channel
Value
Comment
00 [00] I-87061 2 0 0 [40]Digital module
01 [01] I-87061 2 1 0 [40]Digital module
02 [02] I-87061 2 2 0 [40]Digital module
03 [03] I-87061 2 3 0 [40]Digital module
04 [04] I-87061 2 4 0 [40]Digital module
05 [05] I-87061 2 5 0 [40]Digital module
06 [06] I-87061 2 6 0 [40]Digital module
07 [07] I-87061 2 7 0 [40]Digital module
00 [00] I-87061 2 0 1 [40]Digital module
01 [01] I-87061 2 1 1 [40]Digital module
02 [02] I-87061 2 2 1 [40]Digital module
03 [03] I-87061 2 3 0 [40]Digital module
After rebooting the controller, the values for channel 0 to 2 display the Power-on values.

2.9.2. Digital Output Safe Value

If Modbus communication with the controller is lost for longer than the defined timer period, the Watchdog will be triggered and all modules will be set to a preset Safe Value.

In the “DO Safe Value” tab of the DIO Settings dialog box, check the checkbox(es) for the channel(s) to be set, and then click the “Set DO Safe Value” button to apply the Safe value.



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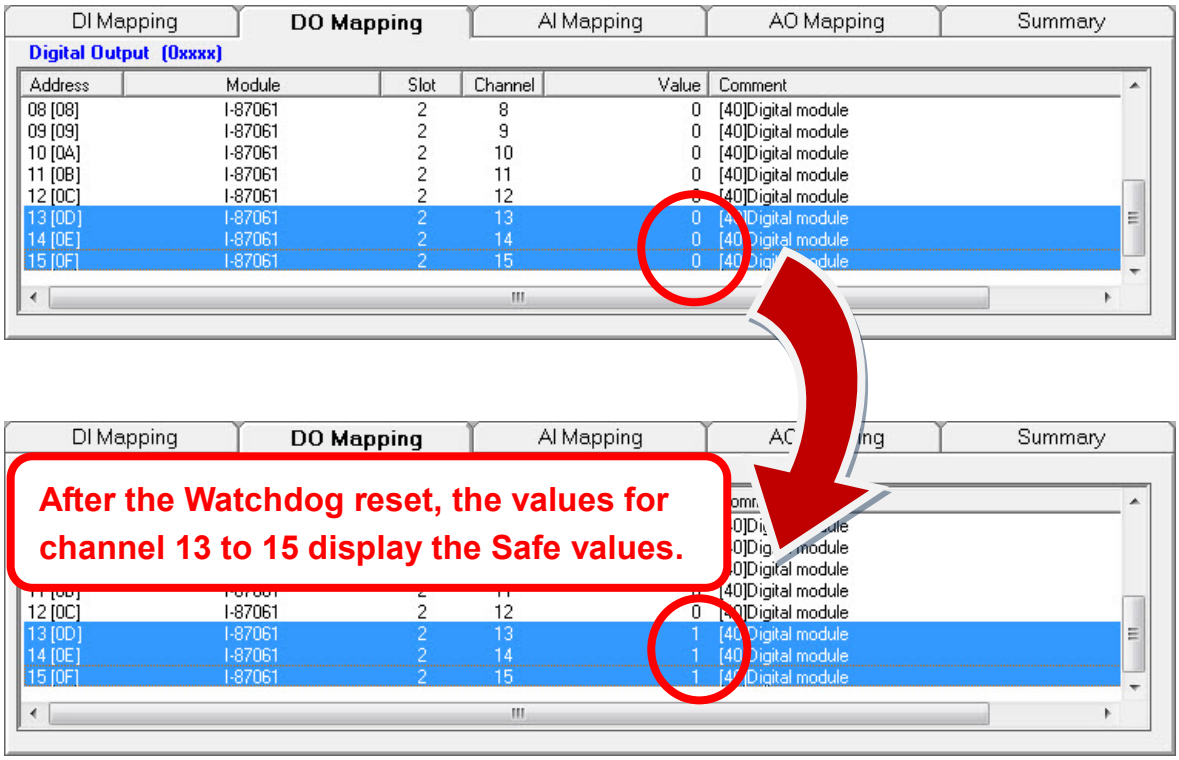
After the Watchdog has been reset the modules, the DO value will be set to the Safe value.


DI Mapping
DO Mapping
AI Mapping
AO Mapping
Summary
Digital Output (0xxxx)
Address
Module
Slot
Channel
Value
Comment
08 [08] I-87061 2 8 0 [40]Digital module
09 [09] I-87061 2 9 0 [40]Digital module
10 [0A] I-87061 2 10 0 [40]Digital module
11 [0B] I-87061 2 11 0 [40]Digital module
12 [0C] I-87061 2 12 0 [40]Digital module
13 [0D] I-87061 2 13 0
14 [0E] I-87061 2 14 0
15 [0F] I-87061 2 15 0
DI Mapping
DO Mapping
AI Mapping
Summary
After the Watchdog reset, the values for channel 13 to 15 display the Safe values.
12 [0C] I-87061 2 12 0
13 [0D] I-87061 2 13 1
14 [0E] I-87061 2 14 1
15 [0F] I-87061 2 15 1

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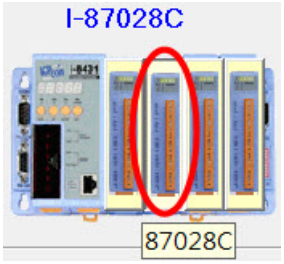
2.10 Analog Output Power-on and Safe Values

To change the Analog Output Power-on and Safe values, click the module that is to be configured to open the Settings panel.

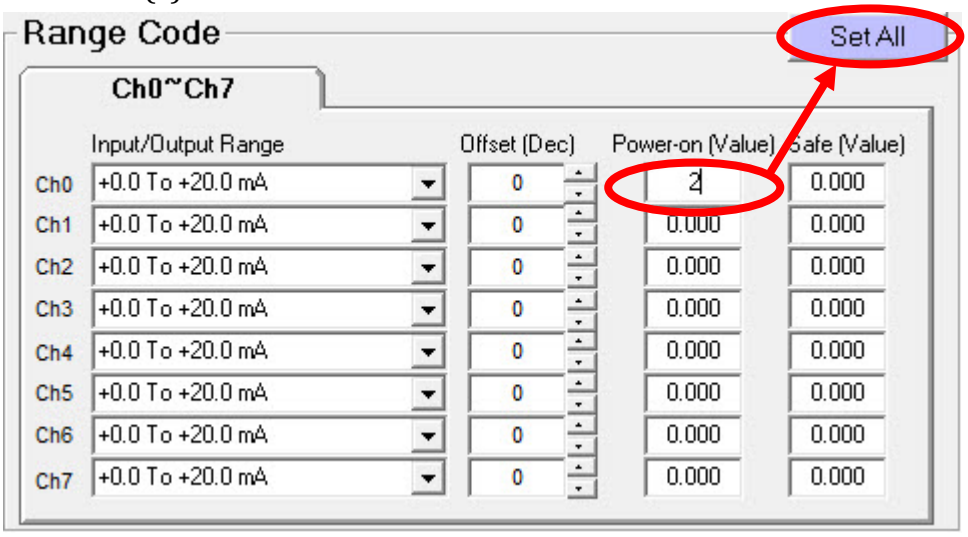


The image here shows the I-87028C module as an example.

2.10.1. Analog Output Power-on value

The Power-on value is the Analog Output value that will be set for the module when the controller is powered on every time.

Step 1: In the Range Code dialog box, enter a Power-on value in the text box(es) for the relevant channel(s), then click the "Set All" button to apply the Power-on value(s).



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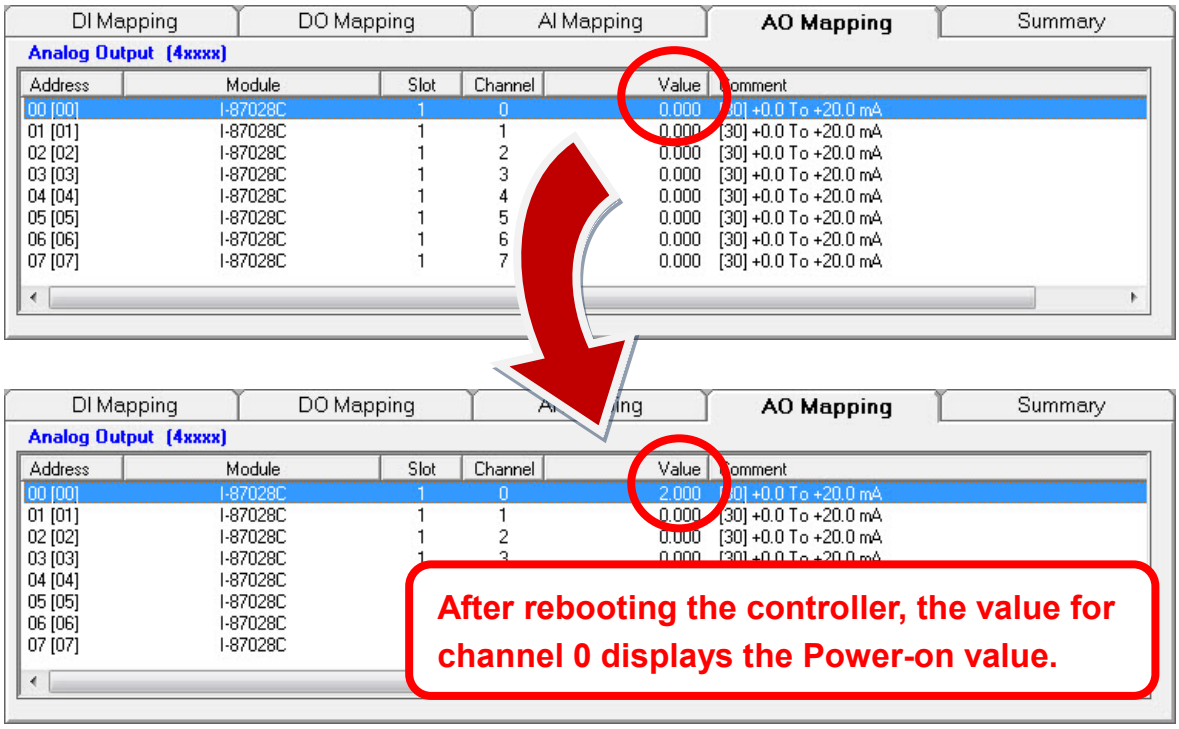
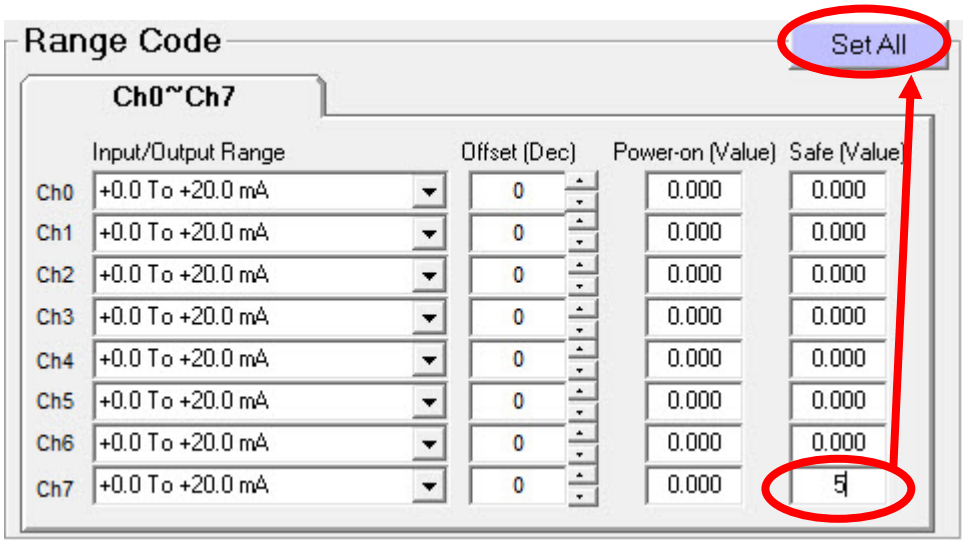
Step 2: The controller should be rebooted if the new Power-on settings would like to be applied. After rebooting, the Power-on value will be displayed for the channel in the AO Mapping tab in monitoring mode, or use a monitoring tool to detect the value.


DI Mapping
DO Mapping
AI Mapping
AO Mapping
Summary
Analog Output (4xxxx)
Address
Module
Slot
Channel
Value
Comment
00 [00] I-87028C 1 0 0.000 [30] +0.0 To +20.0 mA
01 [01] I-87028C 1 1 0.000 [30] +0.0 To +20.0 mA
02 [02] I-87028C 1 2 0.000 [30] +0.0 To +20.0 mA
03 [03] I-87028C 1 3 0.000 [30] +0.0 To +20.0 mA
04 [04] I-87028C 1 4 0.000 [30] +0.0 To +20.0 mA
05 [05] I-87028C 1 5 0.000 [30] +0.0 To +20.0 mA
06 [06] I-87028C 1 6 0.000 [30] +0.0 To +20.0 mA
07 [07] I-87028C 1 7 0.000 [30] +0.0 To +20.0 mA
DI Mapping
DO Mapping
AO Mapping
Summary
Analog Output (4xxxx)
Address
Module
Slot
Channel
Value
Comment
00 [00] I-87028C 1 0 2.000 [30] +0.0 To +20.0 mA
01 [01] I-87028C 1 1 0.000 [30] +0.0 To +20.0 mA
02 [02] I-87028C 1 2 0.000 [30] +0.0 To +20.0 mA
03 [03] I-87028C
04 [04] I-87028C
05 [05] I-87028C
06 [06] I-87028C
07 [07] I-87028C
After rebooting the controller, the value for channel 0 displays the Power-on value.

2.10.2. Analog Output Safe Value

If Modbus communication with the controller is lost for longer than the defined timer period, the Watchdog will be triggered and all modules will be set to a preset Safe Value.

In the Range Code dialog box, enter a Safe value in the text box(es) for the relevant channel(s), then click the "Set All" button to apply the new Safe value(s).



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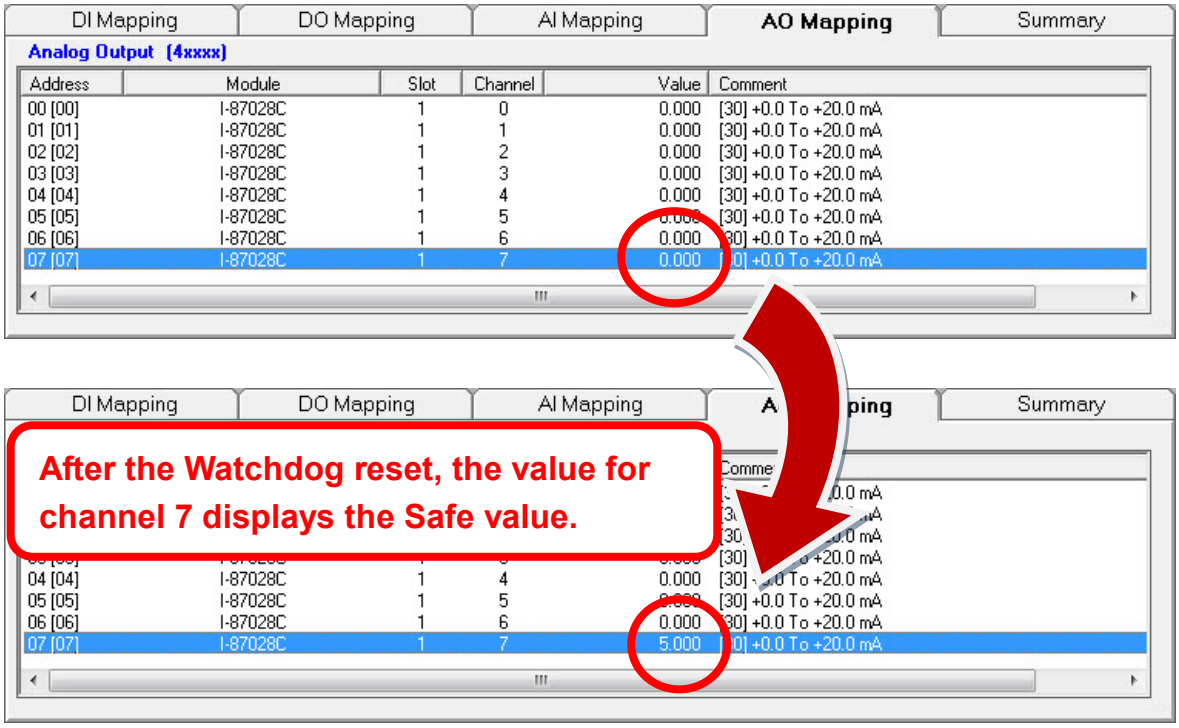
After the Watchdog has been reset the modules, the DO value will be set to the Safe value.



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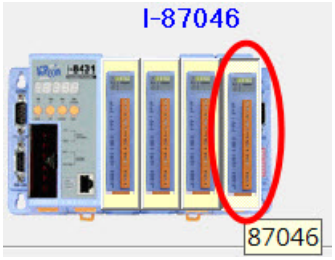
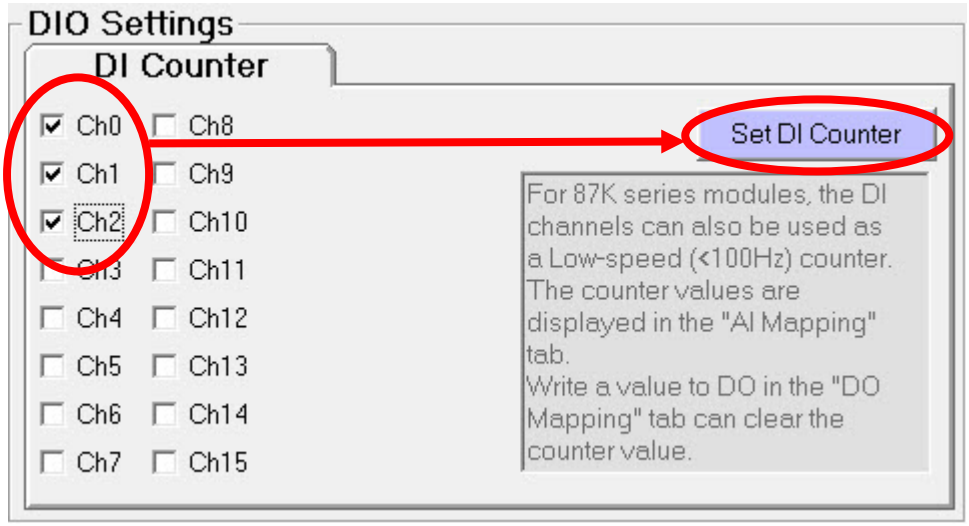
2.11 87K Digital Input Counter

For 87K series modules, the DI channels can also be used as a Low-speed (<100Hz) counter. Click the module that is to be configured to open the Settings panel.

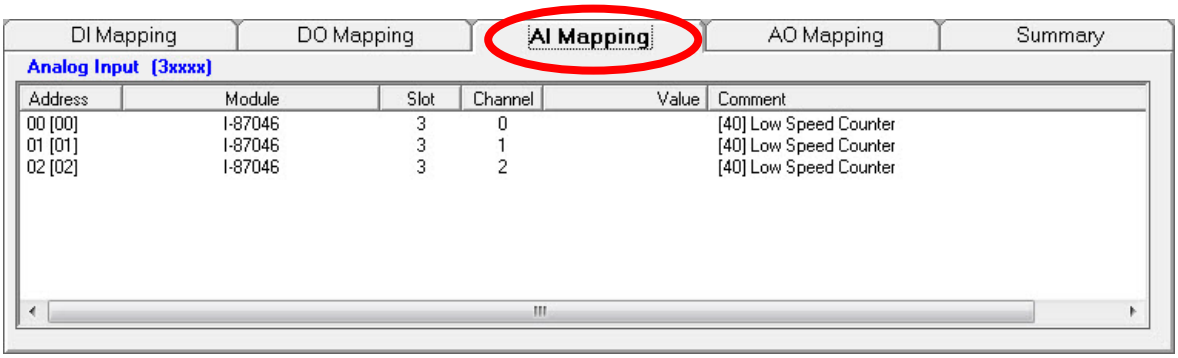


The image here shows the I-87046 module as an example.

Step 1: In the "DI Counter" tab of the DIO Settings dialog box, check the checkbox(es) for the channel(s) to be set, and then click the "Set DI Counter" button to apply the new settings.



The channel set to be a DI counter will be displayed in the AI Mapping tab.



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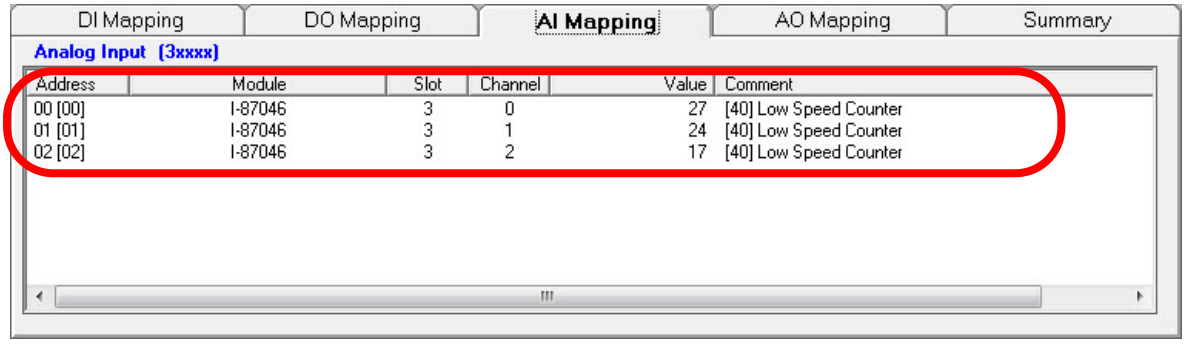
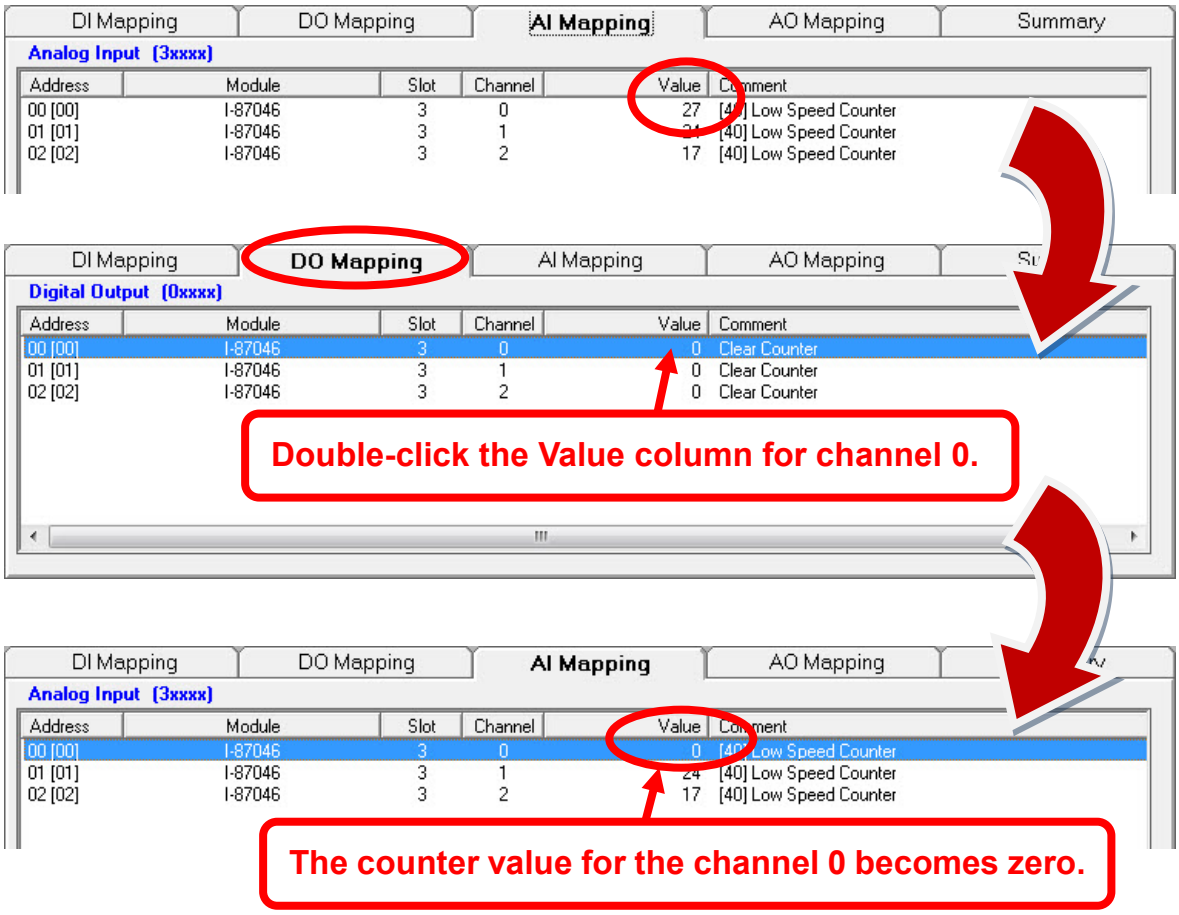
Step 2: After the counter(s) for the DI channel(s) have been set, click the AI Mapping tab to display the channels that have associated counters, together with the current values for the counter.

Note: To get the current counter values needs to enable the Monitoring function first.


DI Mapping
DO Mapping
AI Mapping
AO Mapping
Summary
Analog Input (3xxxx)
Address Module Slot Channel Value Comment
00 [00] I-87046 3 0 27 [40] Low Speed Counter
01 [01] I-87046 3 1 24 [40] Low Speed Counter
02 [02] I-87046 3 2 17 [40] Low Speed Counter

Step 3: To clear counter value, click the DO Mapping tab and then **double-click** the relevant channel. The counter value for the channel will then be set to 0.


DI Mapping
DO Mapping
AI Mapping
AO Mapping
Analog Input (3xxxx)
Address Module Slot Channel Value Comment
00 [00] I-87046 3 0 27 [40] Low Speed Counter
01 [01] I-87046 3 1 24 [40] Low Speed Counter
02 [02] I-87046 3 2 17 [40] Low Speed Counter
Digital Output (0xxxx)
00 [00] I-87046 3 0 0 Clear Counter
01 [01] I-87046 3 1 0 Clear Counter
02 [02] I-87046 3 2 0 Clear Counter
Double-click the Value column for channel 0.
The counter value for the channel 0 becomes zero.

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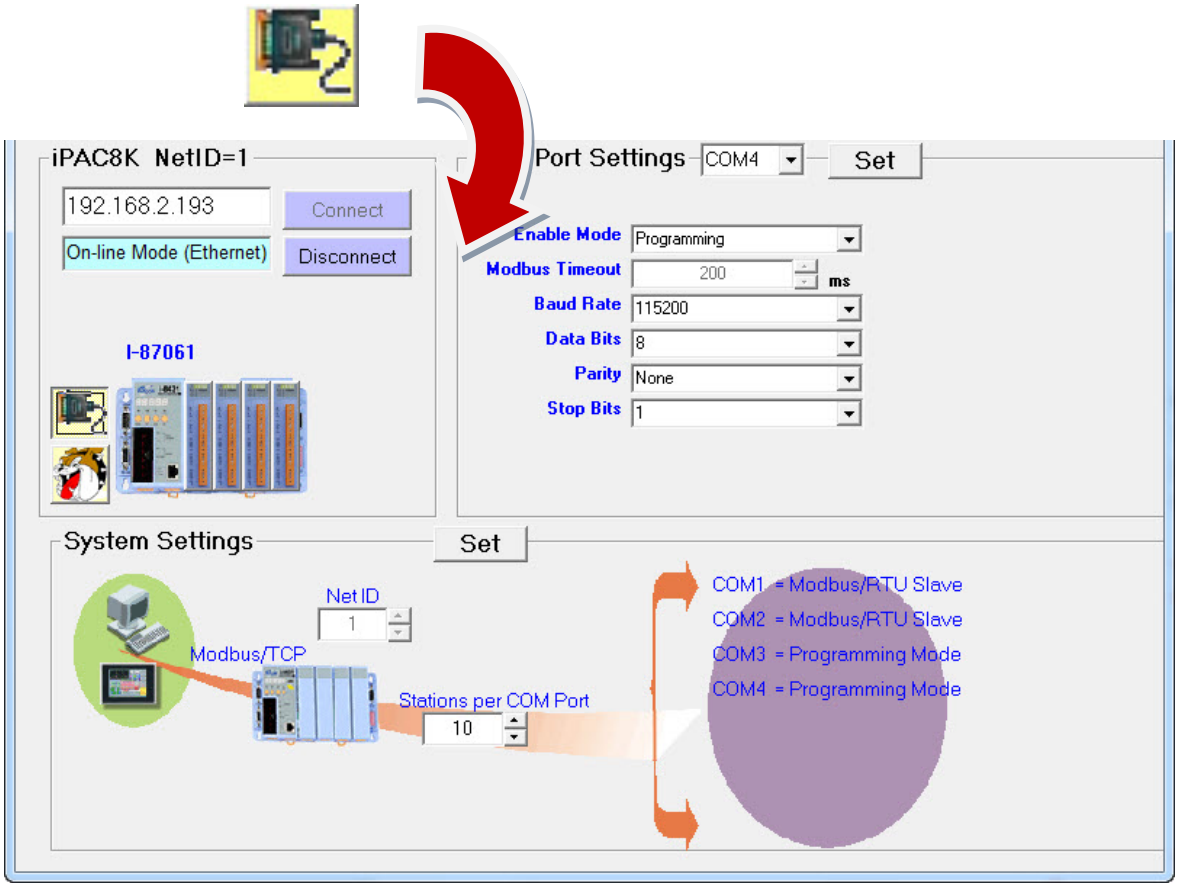
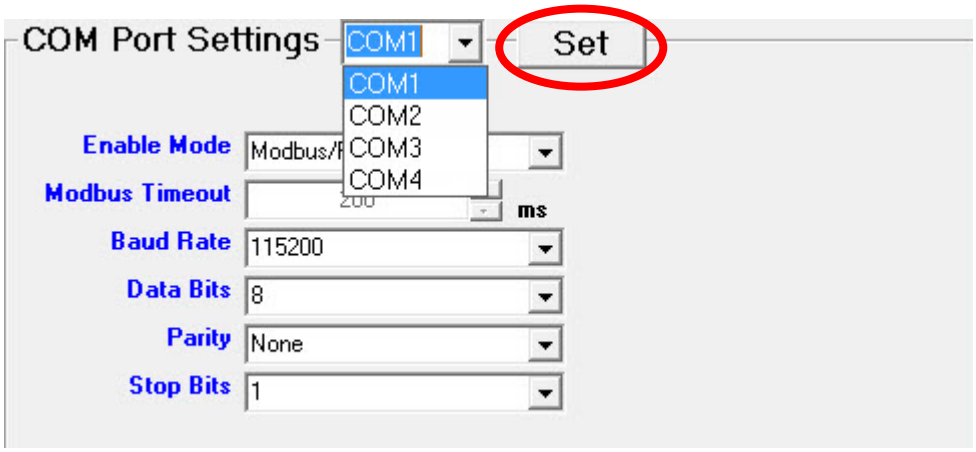
2.12 COM Port Settings

Step 1: To adjust the configuration for the COM ports, click the COM port icon to display the "COM port settings" panel.



Step 2: Select the port to be configured from the drop-down menu, and then select the enable mode, Modbus timeout and the other setting. There are seven modes can be selected for the COM port. When all the settings are done, click the "Set" button to apply for new settings.



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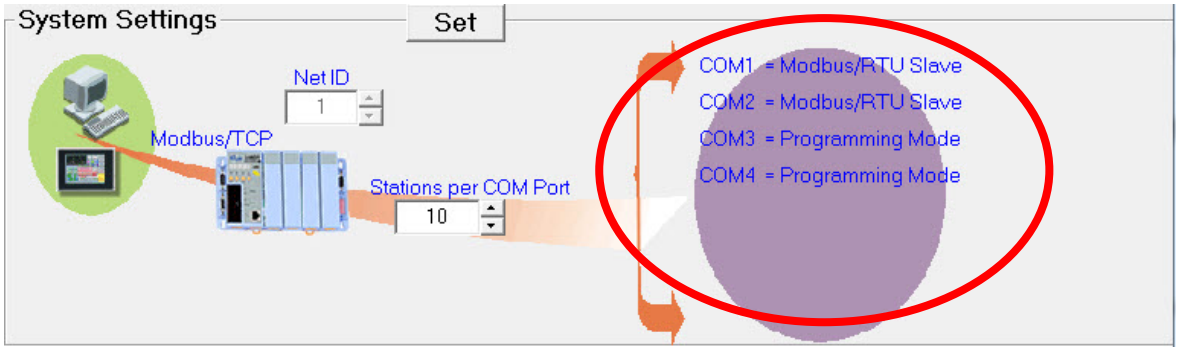
The new settings will be displayed in the “System Settings” panel immediately.

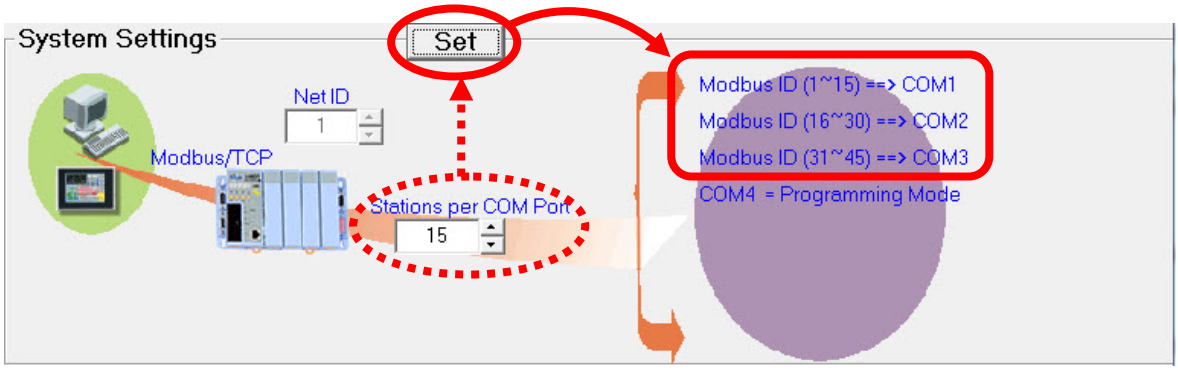


2.12.1. COM Port Enable Modes

Seven modes can be selected for the COM port, each of which are described below.

A. VxComm: This option creates virtual COM ports and maps them to the Ethernet ports on the serial modules.

B. Modbus/RTU Gateway: This option allows the COM port to connect to up to 255 RTU slaves (stations). Enter the number of devices connected to the RTU gateway in the “Stations per COM Port” text field and then click the “Set” button. The Modbus Utility will automatically assign the Slave ID if more than one port is set to the RTU gateway mode.



C. Modbus/RTU Slave: This option is used to set the device to operate as a Modbus/RTU Slave.

D. Modbus/ASCII Slave: This option is used to set the device to operate as a Modbus/ASCII Slave.

E. Programming: This option is used for programming only and will not automatically detect Modbus request.

F. Debug: This option is used to display debug messages relating to Modbus requests, or communication messages, etc. while communicating with a

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Modbus master or Modbus clients.

G. Console: This option is used to perform configuration for file uploads, or updating the firmware for the device.

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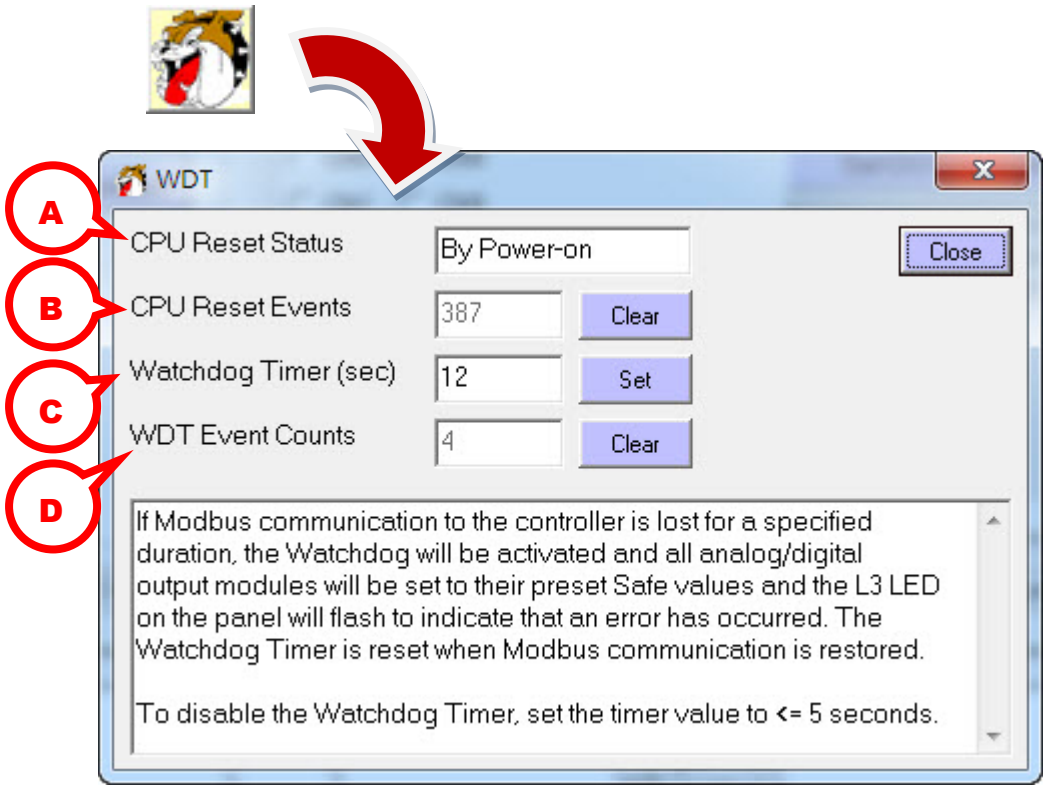
2.13 Watchdog Timer (WDT) Settings

Every controller has the Watchdog that will be activated when crashed or hanged happened to the controller. The Watchdog Timer is to count down when the controller lost the Modbus communication for a specified period. When the Watchdog Timer counts to zero, the Watchdog will be activated and all analog/digital output modules will be set to their preset Safe values and the L3 LED on the panel will flash to indicate that an error has occurred.
Click the Watchdog icon to open the setting panel.


WDT
A
CPU Reset Status
By Power-on
Close
B
CPU Reset Events
387
Clear
C
Watchdog Timer (sec)
12
Set
D
WDT Event Counts
4
Clear
If Modbus communication to the controller is lost for a specified duration, the Watchdog will be activated and all analog/digital output modules will be set to their preset Safe values and the L3 LED on the panel will flash to indicate that an error has occurred. The Watchdog Timer is reset when Modbus communication is restored.
To disable the Watchdog Timer, set the timer value to <= 5 seconds.

A. CPU Reset Status: Indicates whether the current status was set during a normal power-on or if it was reset by the CPU Watchdog.
   By Power on: This status message will be displayed if the controller was started normally.
   By CPU WDT: This status message will be displayed if the controller encountered an error that caused the CPU Watchdog to reboot the controller.

B. CPU Reset Event: Indicates the number of times the controller has been reset due to CPU and power-on events. Clicking the “Clear” button will reset the counter to 0.

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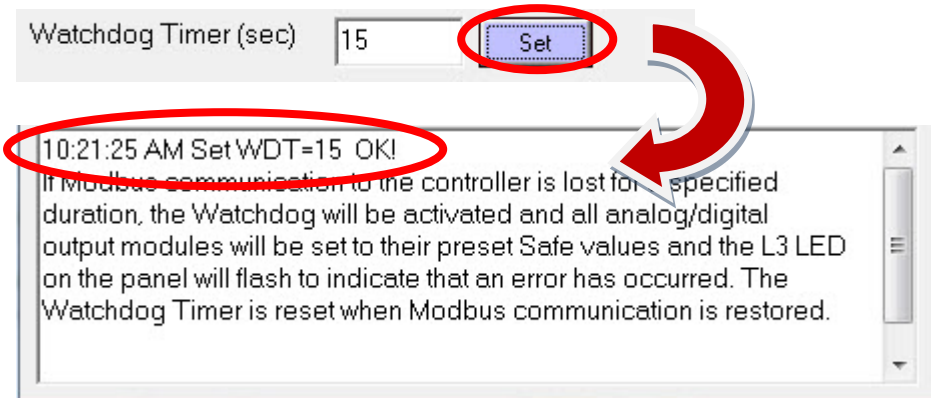
C. Watchdog Timer: Indicates the count-down duration of the Watchdog Timer. To enable the Watchdog Timer, the duration has to be set more than 5 seconds and the “Set” button has to be clicked for applying the duration.


Watchdog Timer (sec)
15
Set
10:21:25 AM Set WDT=15 OK!
If Modbus communication to the controller is lost for specified duration, the Watchdog will be activated and all analog/digital output modules will be set to their preset Safe values and the L3 LED on the panel will flash to indicate that an error has occurred. The Watchdog Timer is reset when Modbus communication is restored.

D. WDT Event Counts: Indicates the number of times the controller has been reset due to Watchdog Timer events. Clicking the “Clear” button will reset the counter to 0.

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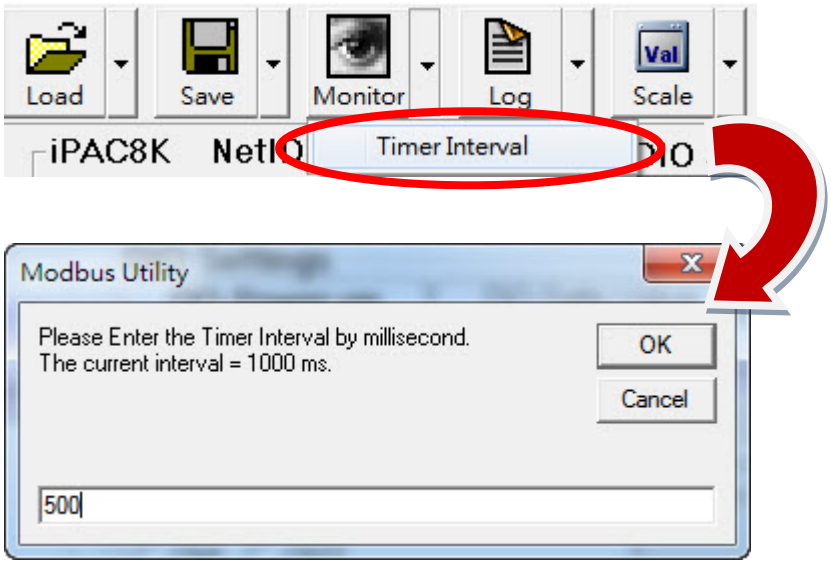
2.14 Monitoring

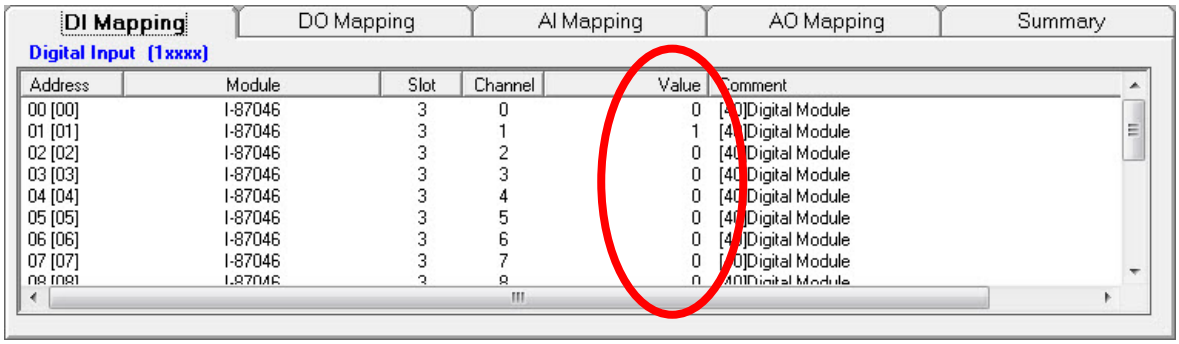
The Monitor function is used to retrieve I/O values immediately and also set the output values.

Step 1: In the monitor drop-down menu, click “Timer interval” to set timer scan interval.



Step 2: Click the “Monitor” button in the tool bar to begin scanning. After the monitoring process begins, the "Monitor" icon will show an active icon as below. To stop monitoring process, click the “Monitor” button again.

The I/O values in the mapping table will be refreshed periodically, but the update frequency depends on the value set for the timer interval.


DI Mapping
DO Mapping
AI Mapping
AO Mapping
Summary
Digital Input (1xxxx)
Address
Module
Slot
Channel
Value
Comment
00 [00] I-87046 3 0 0 [40]Digital Module
01 [01] I-87046 3 1 1 [40]Digital Module
02 [02] I-87046 3 2 0 [40]Digital Module
03 [03] I-87046 3 3 0 [40]Digital Module
04 [04] I-87046 3 4 0 [40]Digital Module
05 [05] I-87046 3 5 0 [40]Digital Module
06 [06] I-87046 3 6 0 [40]Digital Module
07 [07] I-87046 3 7 0 [40]Digital Module

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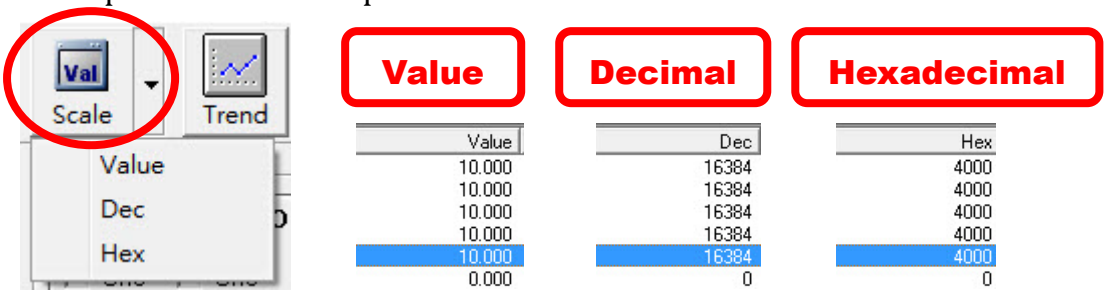
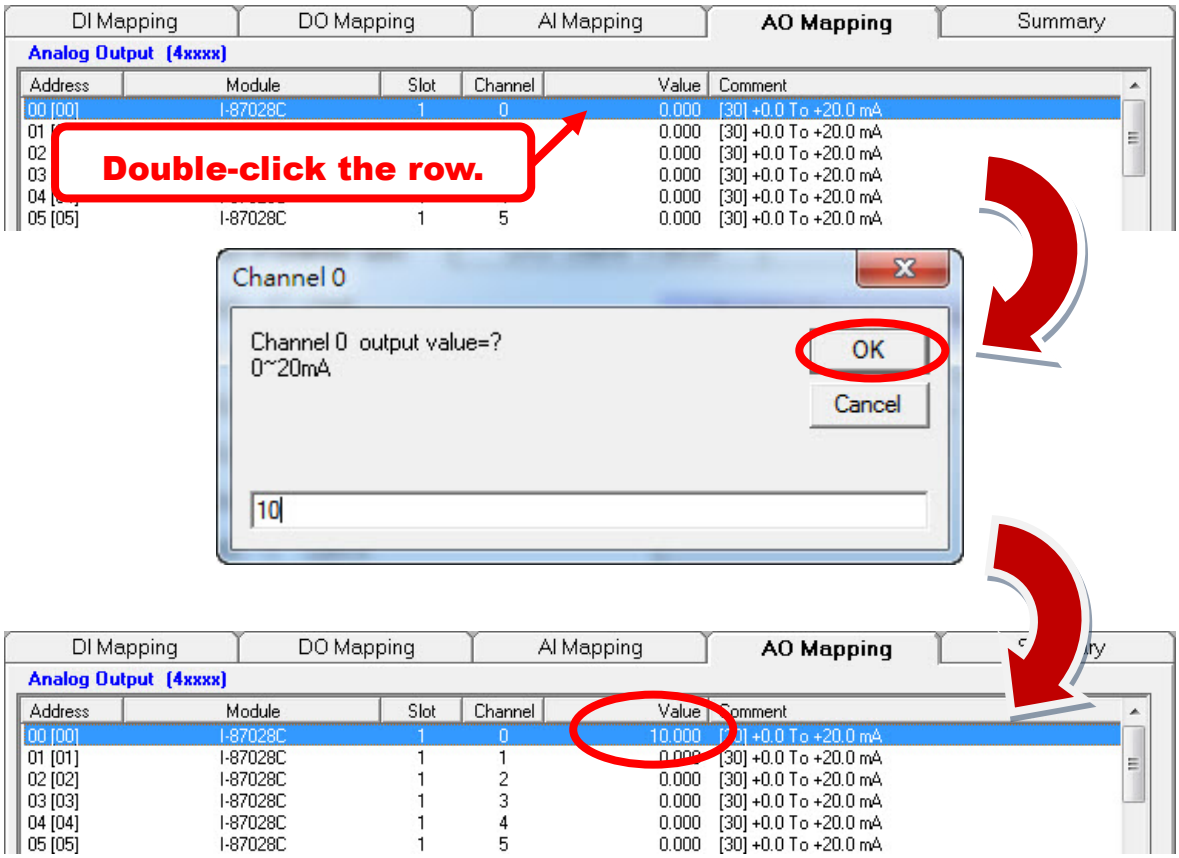
Step 3: The display mode for analog modules can be changed to either Value, Decimal or Hexadecimal format. Click the "Scale" button and select the desired option from the drop-down list.



Step 4: This step is to set the output values for analog output modules. To change the output values for a specific channel, double-click the row to relevant channel in the AO Mapping table to open the "Channel" dialog box. Enter the value and then click the "OK" button. The value to the channel will be changed.


DI Mapping
DO Mapping
AI Mapping
AO Mapping
Summary
Analog Output (4xxxx)
Address
Module
Slot
Channel
Value
Comment
00 [00] I-87028C 1 0 0.000 [30] +0.0 To +20.0 mA
01 [01] I-87028C 1 1 0.000 [30] +0.0 To +20.0 mA
02 [02] I-87028C 1 2 0.000 [30] +0.0 To +20.0 mA
03 [03] I-87028C 1 3 0.000 [30] +0.0 To +20.0 mA
04 [04] I-87028C 1 4 0.000 [30] +0.0 To +20.0 mA
05 [05] I-87028C 1 5 0.000 [30] +0.0 To +20.0 mA
Double-click the row.
Channel 0
Channel 0 output value=?
0~20mA
OK
Cancel
10
DI Mapping
DO Mapping
AI Mapping
AO Mapping
Analog Output (4xxxx)
Address
Module
Slot
Channel
Value
Comment
00 [00] I-87028C 1 0 10.000 [30] +0.0 To +20.0 mA
01 [01] I-87028C 1 1 0.000 [30] +0.0 To +20.0 mA
02 [02] I-87028C 1 2 0.000 [30] +0.0 To +20.0 mA
03 [03] I-87028C 1 3 0.000 [30] +0.0 To +20.0 mA
04 [04] I-87028C 1 4 0.000 [30] +0.0 To +20.0 mA
05 [05] I-87028C 1 5 0.000 [30] +0.0 To +20.0 mA

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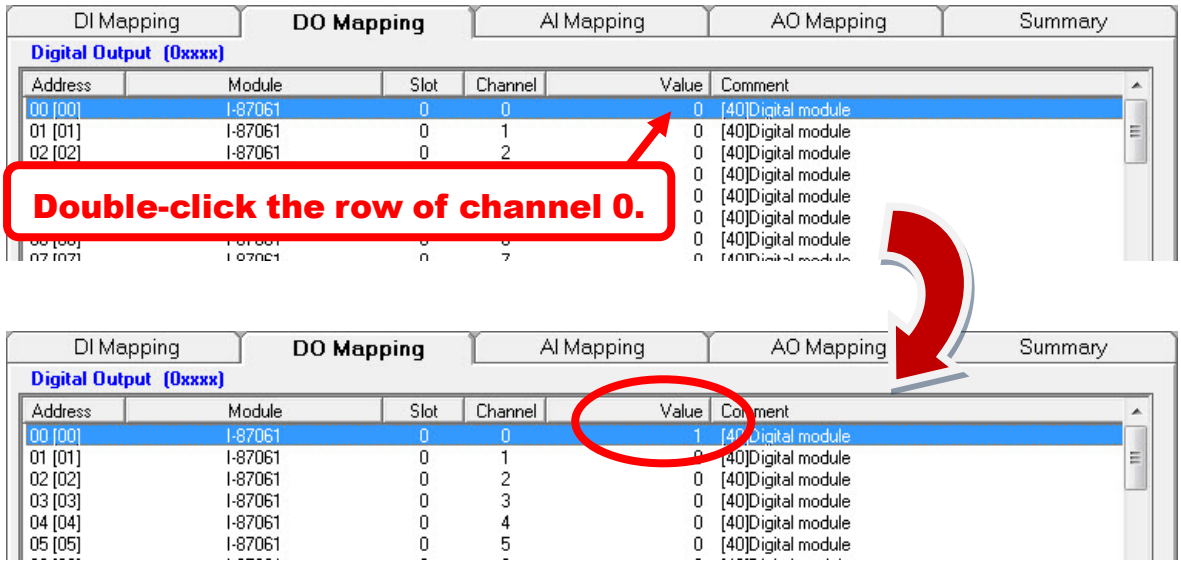
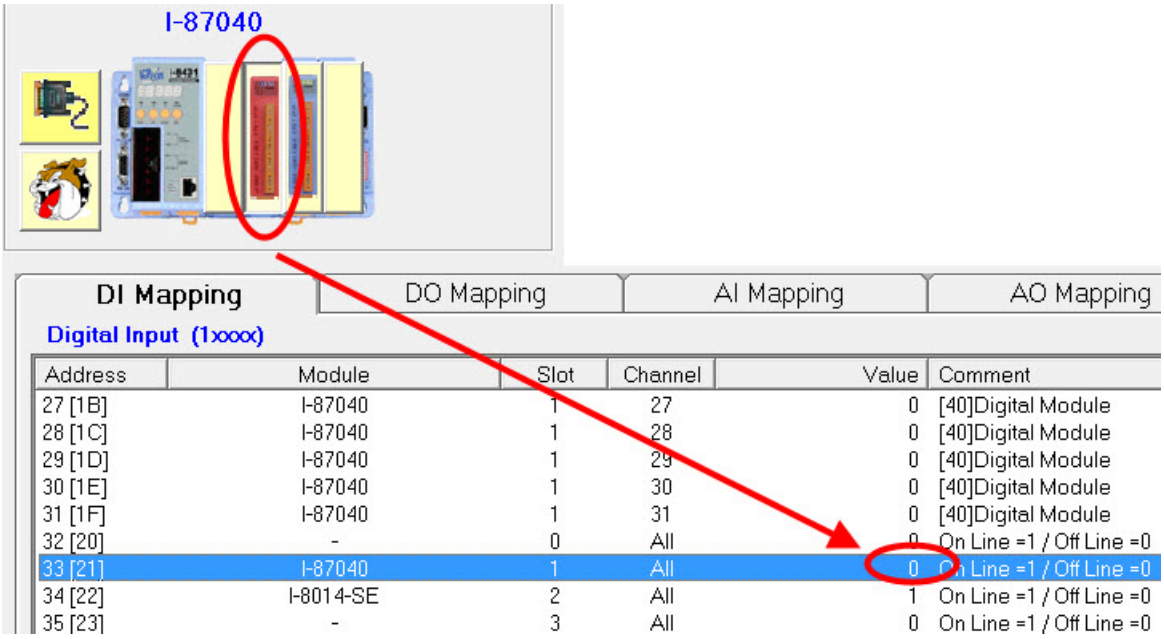
Step 5: This step is to set the output values for digital output modules. To change the output values for a specific channel, double-click the row to relevant channel in the DO Mapping table. The value to the channel will be changed immediately.


DI Mapping
DO Mapping
AI Mapping
AO Mapping
Summary
Digital Output (0xxxx)
Address Module Slot Channel Value Comment
00 [00] I-87061 0 0 0 [40]Digital module
01 [01] I-87061 0 1 0 [40]Digital module
02 [02] I-87061 0 2 0 [40]Digital module
Double-click the row of channel 0.
DI Mapping
DO Mapping
AI Mapping
AO Mapping
Summary
Digital Output (0xxxx)
Address Module Slot Channel Value Comment
00 [00] I-87061 0 0 1 [40]Digital module
01 [01] I-87061 0 1 0 [40]Digital module
02 [02] I-87061 0 2 0 [40]Digital module
03 [03] I-87061 0 3 0 [40]Digital module
04 [04] I-87061 0 4 0 [40]Digital module
05 [05] I-87061 0 5 0 [40]Digital module

Note: The Modbus Utility also has an alert system that warns when an 87K module is off line. If the module is off line, the image for the unit will be displayed in red and the value in the DI Mapping table will be shown as 0. Both the image and the value will return to normal once the module is online.


I-87040
DI Mapping
DO Mapping
AI Mapping
AO Mapping
Digital Input (1xxxx)
Address Module Slot Channel Value Comment
27 [1B] I-87040 1 27 0 [40]Digital Module
28 [1C] I-87040 1 28 0 [40]Digital Module
29 [1D] I-87040 1 29 0 [40]Digital Module
30 [1E] I-87040 1 30 0 [40]Digital Module
31 [1F] I-87040 1 31 0 [40]Digital Module
32 [20] - 0 All 0 On Line =1 / Off Line =0
33 [21] I-87040 1 All 0 On Line =1 / Off Line =0
34 [22] I-8014-SE 2 All 1 On Line =1 / Off Line =0
35 [23] - 3 All 0 On Line =1 / Off Line =0

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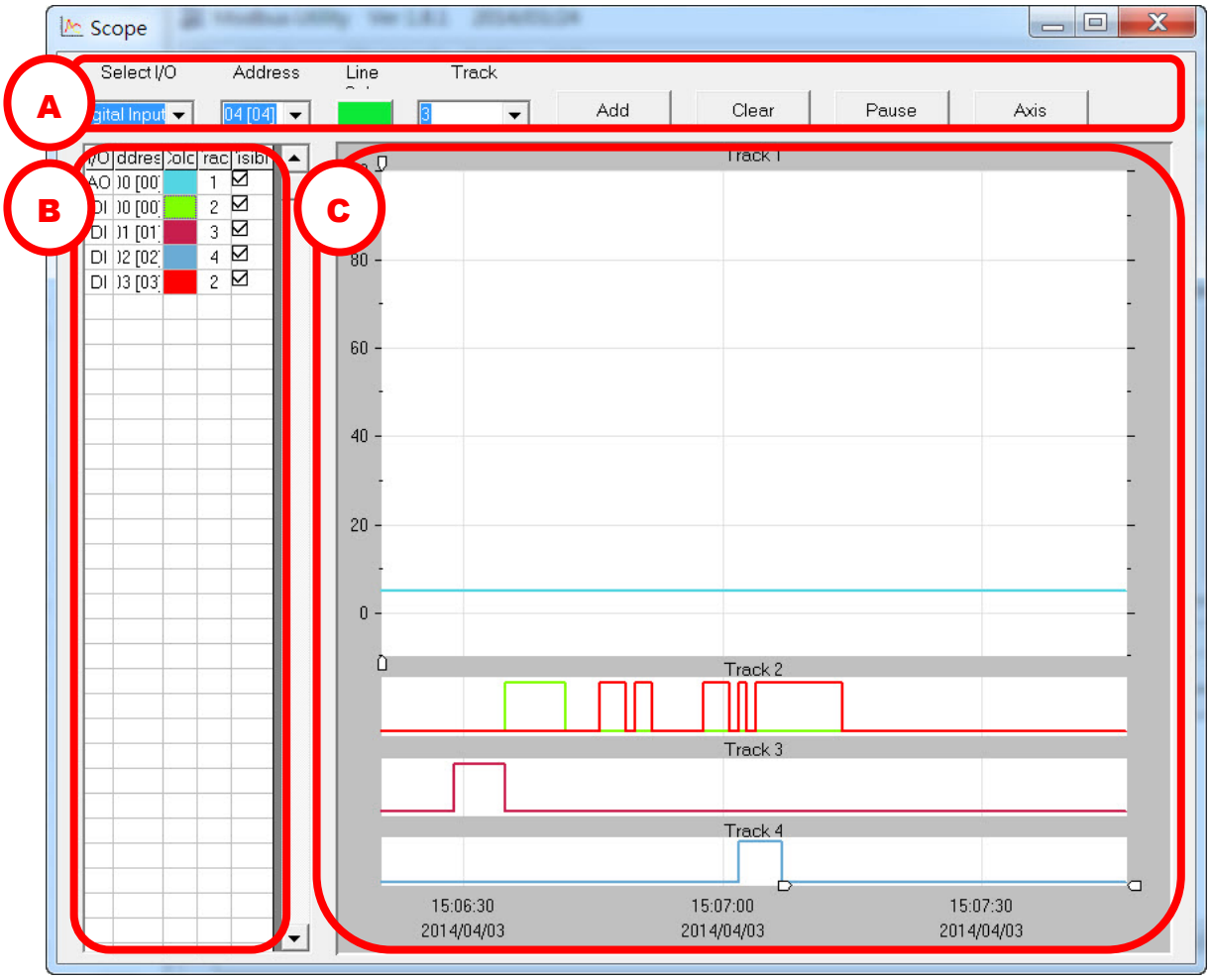
2.15 Trend

In addition to retrieving data values from the address table, the Trend function can be used to monitor data and display it as a trend chart. The following illustration is the working area of the Trend function.



A. Setting and control area: In this area can set condition to add an address, and to start or stop monitoring, and change the scope range.

B. List of trend chart area: In this area can display the addresses that were added to Track area, and adjust the settings for respective address, and set the output values to the addresses of DO/AO.

C. Track area: The Trend function has four areas to monitor and display the data, and these four areas are named as Track 1, Track 2, Track 3 and Track 4. Track 1 can only display analog module trend lines, and Track 2 to 4 can display digital module trend lines.

The following procedures indicate the setting to retrieve data.

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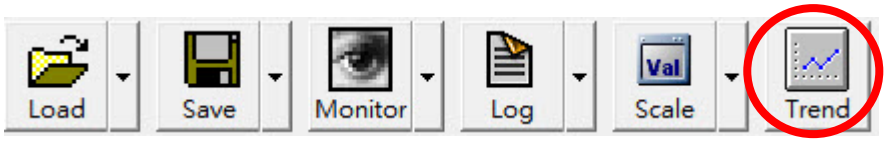
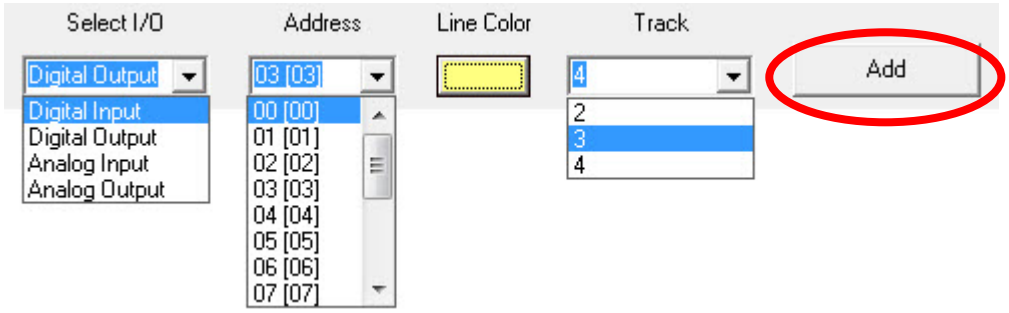
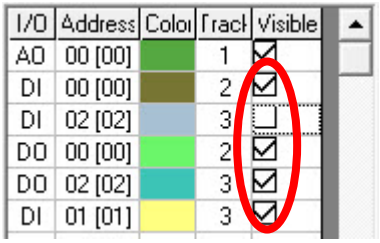
Step 1: Click the "Trend" button on the main menu to open the "Scope" dialog box.



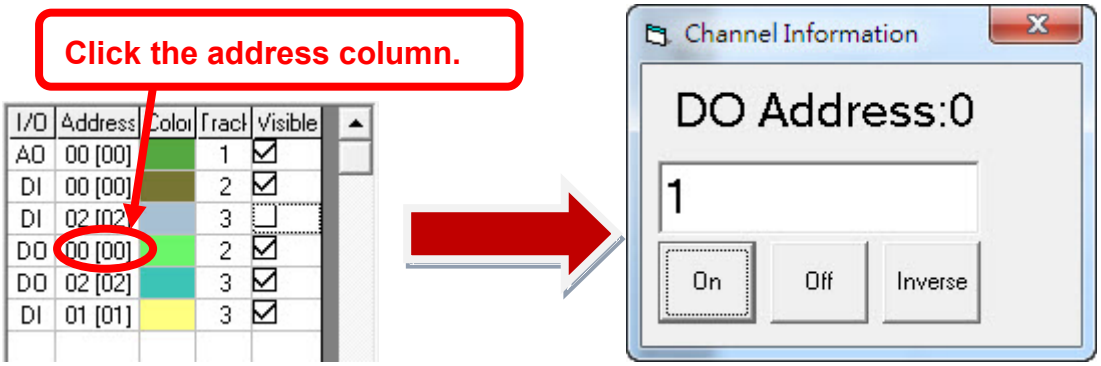
Step 2: To record I/O data on the trend chart, select the I/O type and address from the respective drop-down menus. Select a color for the chart line and assign a track number, and then click the "Add" button to add the record to the Track area.



After adding the address to the Track area, the address can be set visible or not on the Track area by clicking the checkbox or change line color by clicking the color column.



Step 3: To set the output values for the DO addresses, click the address column and then the "Channel Information" dialog box will show. Click the "On" button to set the value of DO address to on and click the "Off" button to set the value to off, and click the "Inverse" button to set the value contrary to current value.



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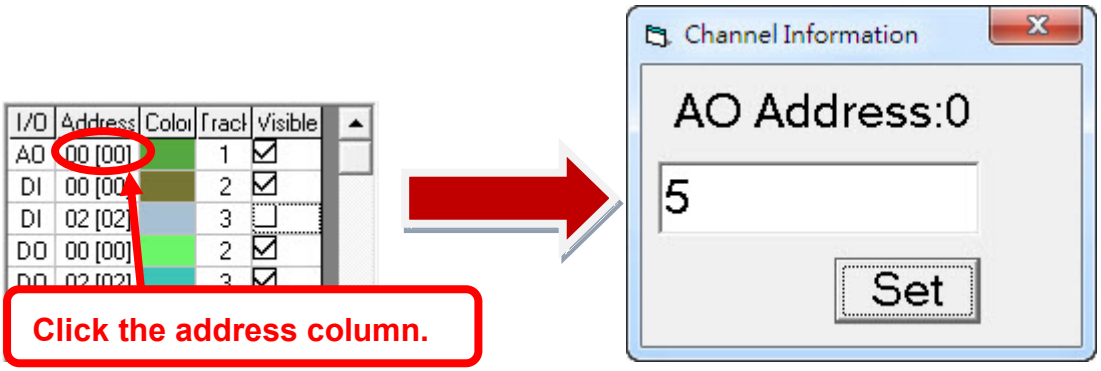
Step 4: To set the output values for the AO addresses, click the address column and then the "Channel Information" dialog box will show. Enter the output value and then click the "Set" button to apply the setting.



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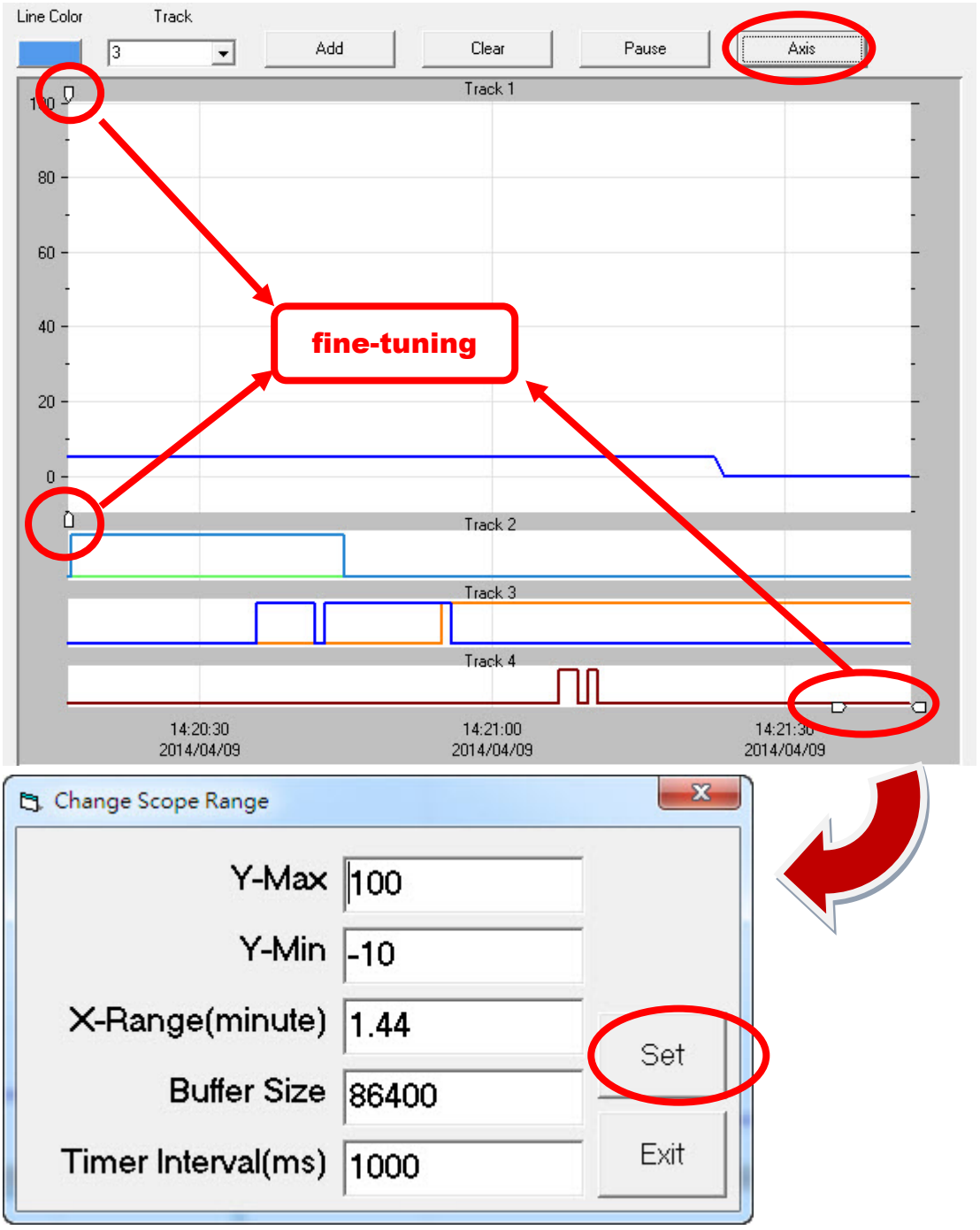
Step 5: To change the scope range, click the "Axis" button to open the "Change Scope Range" dialog box. Adjust the settings as necessary and then click the "Set" button. The details shown in the "Change Scope Range" dialog box can also be fine-tuned by dragging either of the scale arrows illustrated in the image below.



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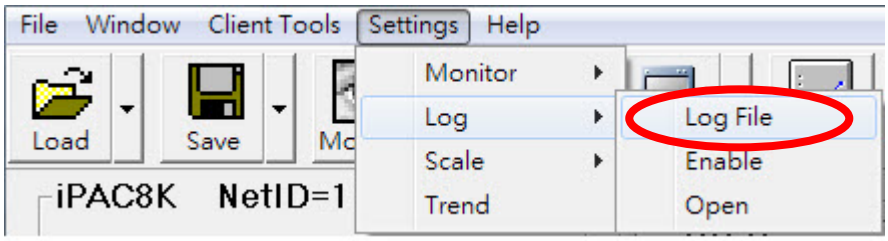
2.16 Data Log

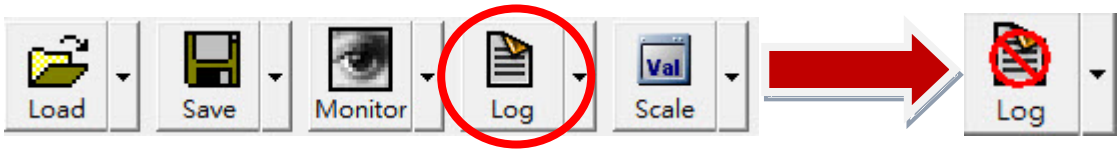
The data log function can be used to record the configuration of the modules, together with the current values, and then save the information as a text file.

Note: The Monitoring function must be active before the Data Log function can be activated.

Step 1: First, set a name for the log file by clicking the “Log File” option from the “Log” drop-down menu in the “Settings” menu. If a name is not set for the log file, the default file name "yyyymmdd.txt" will be used and stored in the "log" subdirectory.



Step 2: Click the “Log” icon to begin recording log data. Once recording begins, the Log icon will show an active icon as below.



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Step 3: To open the data log file, click the "Log" icon to stop recording first and then click the "Open Log" option in the drop-down menu of "Log" icon to open the data log. The I/O data will be display in the data log text file.

20140409.txt - Notepad

File Edit Format View Help

```
Address reference mapping of Modbus TCP
iPAC8K    NetID=1
I-87061(Slot0) + I-87028C(Slot1) + I-87028U(Slot2) + I-87046(Slot3) +
IP address: 192.168.2.193
Modbus firmware version: v1.7.2 [Jan 03 2012]
I/O scan lib version: v1.6.4 [Aug 12 2013]
Data: 4/9/2014
Time: 1:57:32 PM
```

Summary

Slot	Module	DI address	Point	DO address	Point	AI address	Point	AO address	Point
0	I-87061	-	-	00 [00]	16	-	-	-	-
1	I-87028C	-	-	-	-	-	-	00 [00]	8
2	I-87028U	-	-	-	-	-	-	08 [08]	8
3	I-87046	00 [00]	16	-	-	-	-	-	-
3	I-87046	-	-	16 [10]	3	00 [10]	3	-	-
ALL	Status	16 [10]	4	-	-	-	-	-	-

```
15 [0F]        I-87028U          2          7          0          [30] +0.0 To +20.0 mA
=========DI====DI====DI====DI====DI====DI====DI====DI====DI====DI====DI====DI====DI====DI====DI====
    Time, sampling, [00], [01], [02], [03], [04], [05], [06], [07], [08], [09], [10], [11], [12], [13], [14], [
 13:57:32,        0,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,
 13:57:33,        1,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,
 13:57:34,        2,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,
 13:57:35,        3,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,
 13:57:36,        4,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,
 13:57:37,        5,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,
 13:57:38,        6,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,
 13:57:39,        7,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,
 13:57:40,        8,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,
 13:57:41,        9,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,
 13:57:42,       10,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,
 13:57:43,       11,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,
 13:57:44,       12,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,
 13:57:45,       13,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,
 13:57:47,       14,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,
 13:57:48,       15,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,
 13:57:49,       16,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,
 13:57:50,       17,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,
 13:57:51,       18,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,
 13:57:52,       19,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,
 13:57:53,       20,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,
 13:57:54,       21,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,
 13:57:55,       22,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,
 13:57:56,       23,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,
 13:57:57,       24,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,
 13:57:58,       25,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,
 13:57:59,       26,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,
 13:58:00,       27,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,
 13:58:01,       28,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,
 13:58:02,       29,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,
 13:58:03,       30,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,
 13:58:04,       31,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,
 13:58:05,       32,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,
 13:58:06,       33,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,
 13:58:07,       34,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,
 13:58:08,       35,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,
 13:58:09,       36,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,
```

Ln 1, Col 1

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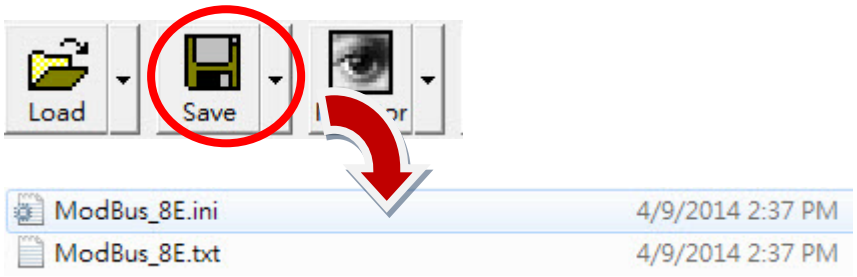
2.17 Save and Load the Configuration Settings

The Modbus Utility allows the configuration of the module to be saved for future use, meaning that it can be loaded the next time the Modbus Utility is used without needing to set the configuration again.

After clicking the "Save" icon, the Modbus Utility will generate two files. The default file names are Modbus_8E.ini and Modbus_8E.txt.



Two methods can be used to review the settings of both a specific controller and each module that is inserted in it.

A. Using the Modbus Utility: Click the "Load" icon to load the .ini file to the Modbus Utility.

B. Using a text editor (such as Notepad): Open the .txt file in the text editor to view the details.

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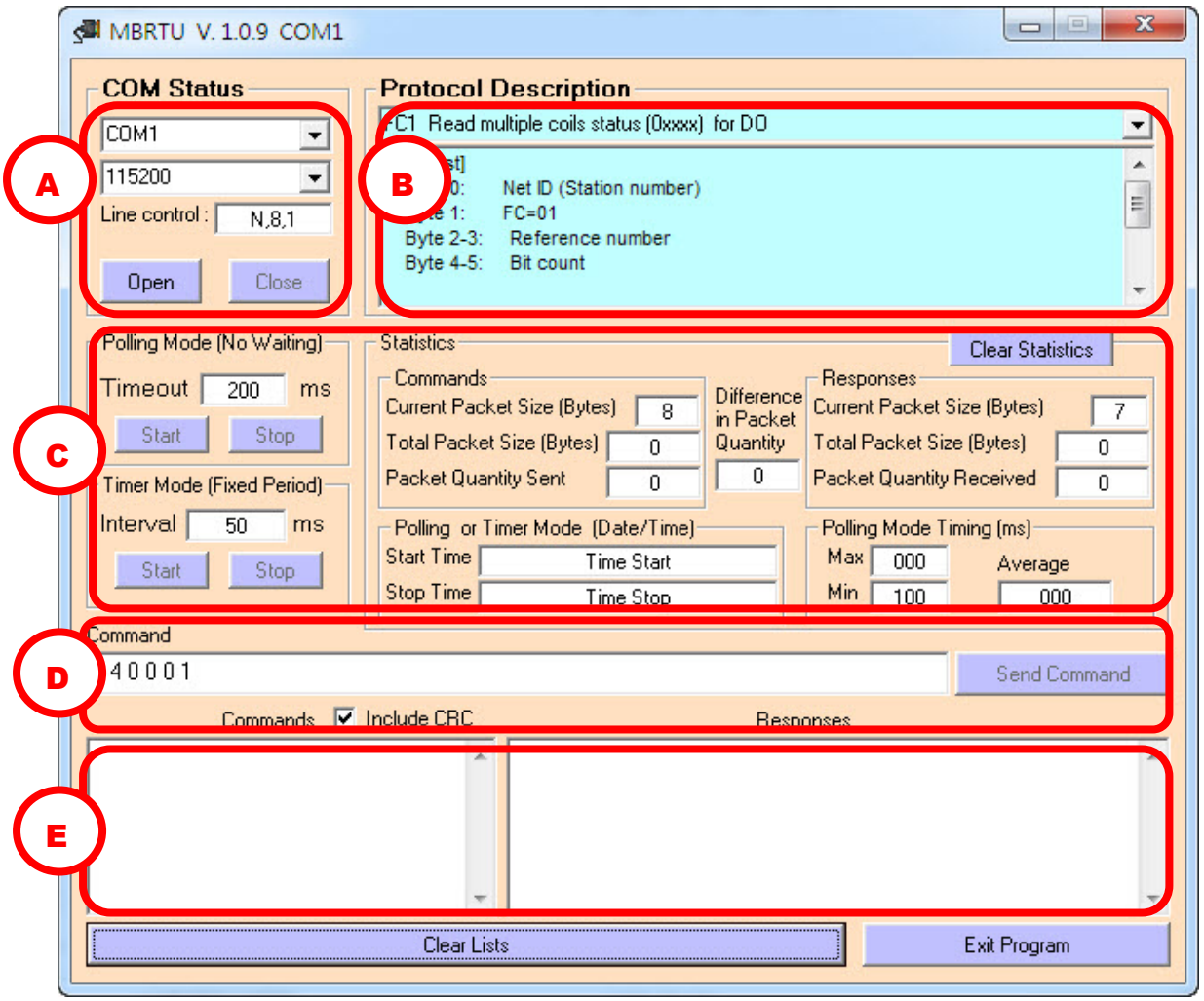
2.18 Modbus RTU Master Tool

The Modbus RTU (MRTU) Master Tool can be used to send Modbus message to read or write I/O values via the COM port. The following image provides an overview of the MRTU Master Tool interface.



A. COM Status: Connect to the controller is related to the "Open" button and disconnect to the controller is related to the "Close" button.

B. Protocol Description: This section provides a description of the request and the response. For more detailed information regarding this section, see Appendix B: Function Codes (FC)

C. Polling Mode: The waiting period to this mode will not be more than the timeout. The next command will be sent immediately once receive the response. This mode is used to perform the transmitting time and the timeout is set to be the maximum waiting period. Click the "Start" button to activate Polling Mode and click the "Stop" button to cancel it.

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Timer Mode: Enter a value that must elapse before a command is sent in the "Interval" textbox. Click the “Start” button to activate Timer Mode and click the “Stop” button to cancel it.

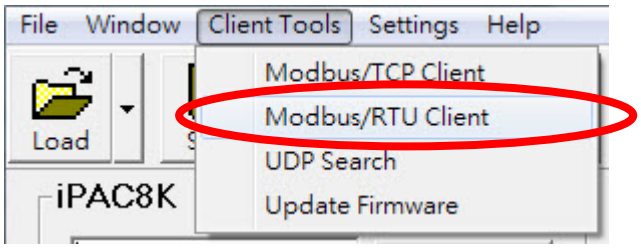
D. Command: This section is used to enter commands. Click the “Send Command” button to transmit to commands.

E. Command/Response: Commands sent to the controller will be displayed in the left-hand text field, and the related response will be displayed on the right.

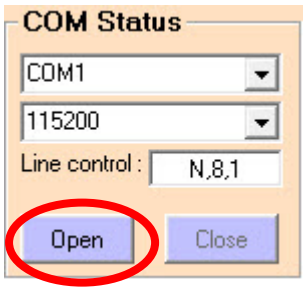
Use the following procedure to send a Modbus command.

Step 1: Set the COM Port mode to Modbus RTU Slave. For more details of the procedure, see Section 2.12 COM Port Settings.

Step 2: Click the “Modbus/RTU Client” option from the “Clients tools” menu.



Step 3: In the COM Status section, select COM Port and Baud Rate from the respective drop-down menus and then click the "Open" button to establish a connection to the COM Port.



Step 4: In the Command section, enter a command and click the "Send Command" button to transmit the command. Ensure that the "Include CRC" option is checked to automatically add a Checksum to the end of the command.

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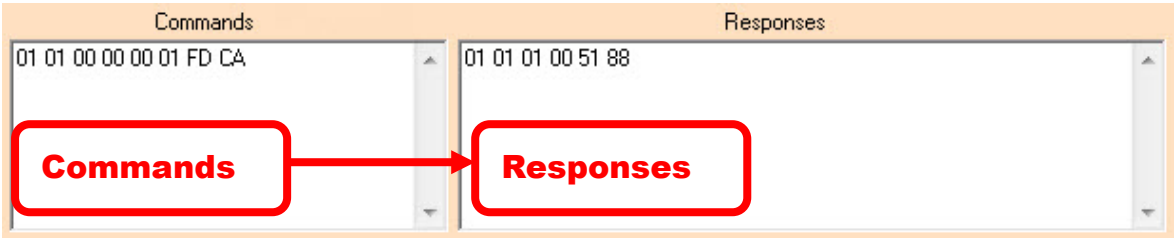
Step 5: The command will be displayed on the left-hand side of the Command/Response window, and the response will be shown on the right-hand side. Note that the last two bytes are the CRC.



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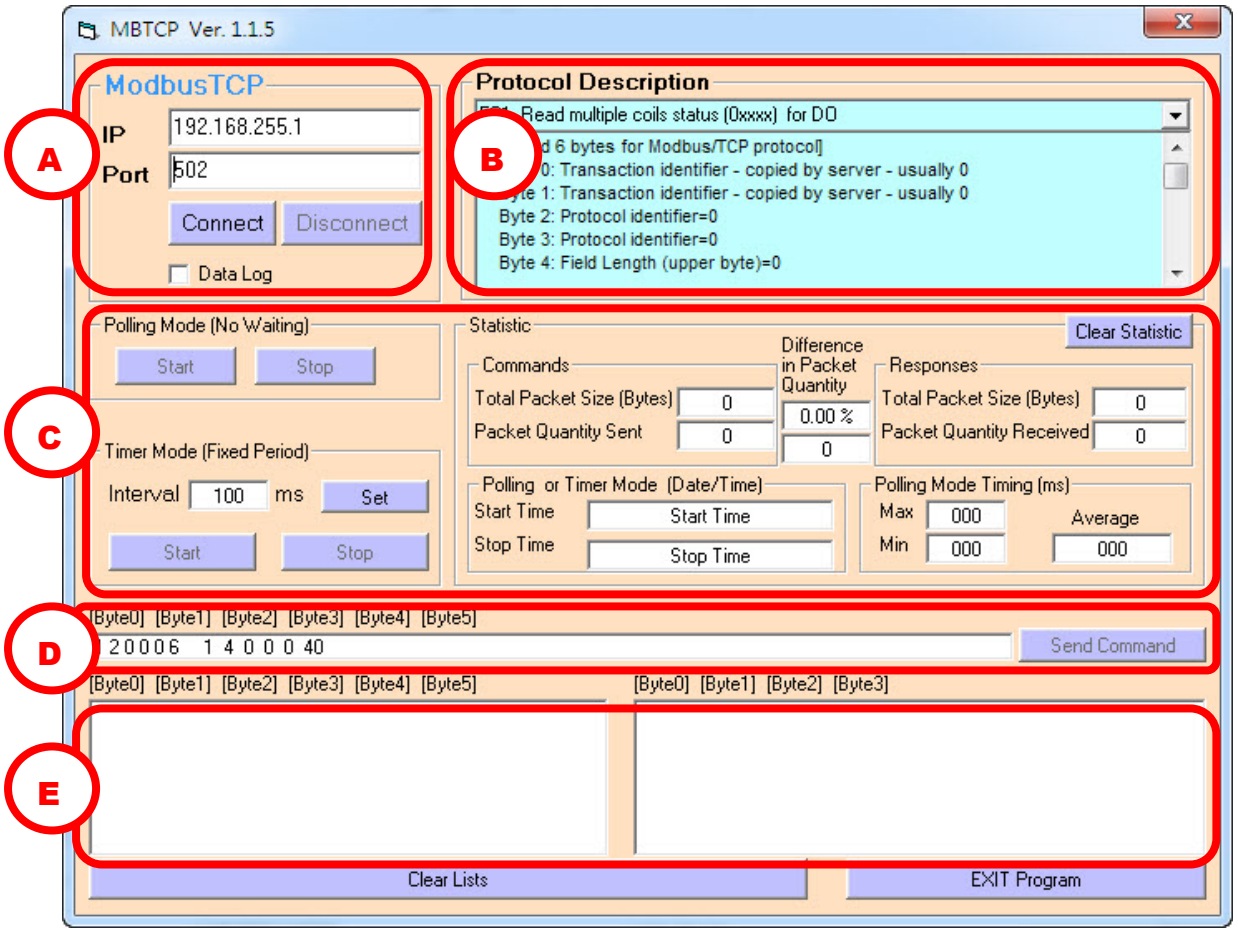
2.19 Modbus TCP Client Tool

The Modbus TCP (MTCP) Client Tool can be used to send Modbus message to read or write I/O values via the Ethernet. The following image provides an overview of the MTCP Master Tool interface.



A. Modbus TCP: Click the “Connect” button to connect the controller using the selected IP address and Port number. Click the “Disconnect” button to end the connection.

B. Protocol Description: This section provides a description of the request and the response. Note that a 6-byte prefix must be used for the Modbus TCP protocol. For more detailed information regarding this section, see Appendix B: Function Codes (FC).

C. Polling Mode: This mode is used to perform the transmitting time. The next command will be sent immediately once receive the response. Click the “Start” button to activate Polling Mode and click the “Stop” button to cancel it.

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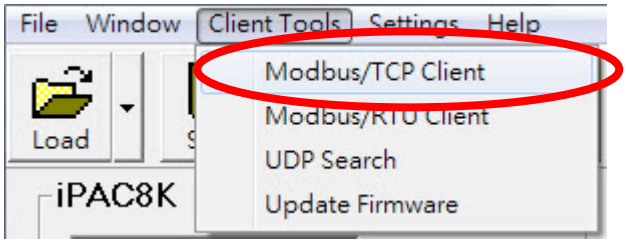
Timer Mode: Enter a value that must elapse before a command is sent in the "Interval" textbox and then click the "Set" button. Click the "Start" button to activate Timer Mode and click the "Stop" button to cancel it

D. Command: This section is used to enter commands. Enter the command, including the 6-byte Modbus TCP prefix, and then click the “Send Command” button to transmit the command.

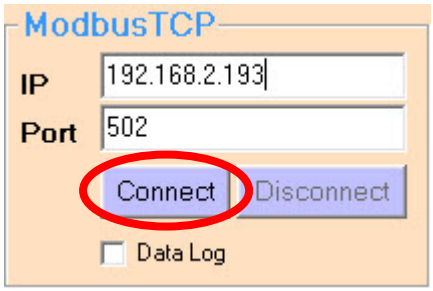
E. Command/Response: Commands sent to the controller will be displayed in the left-hand text field, and the related response will be displayed on the right.

Use the following procedure to send a Modbus command.

Step 1: Click the "Modbus/TCP Client" option from the "Clients tools" menu.



Step 2: In the Modbus TCP section, enter the IP address and the Port number in the respective textboxes and then click the "Connect" button to establish a connection. If you also wish to create a data log, click the "Data Log" checkbox.



Step 3: In the Command section, enter a command and click the "Send Command" button to transmit the command.

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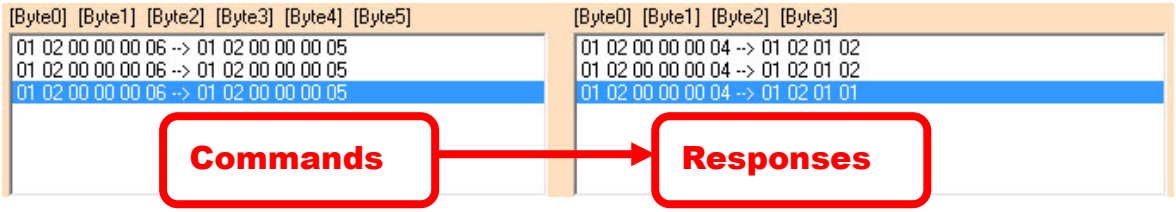
Step 4: The command will be displayed on the left-hand side of the Command/Response window, and the response will be shown on the right-hand side.



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3. Linking to SCADA Software via Modbus

This chapter provides a description of how to connect SCADA (Supervisor Control and Data Acquisition) applications to Modbus in order to retrieve I/O values via Modbus/TCP protocol. The SCADA will be described in this chapter are:

- Vijeo Citect
- DASYLab
- EZ Data Logger

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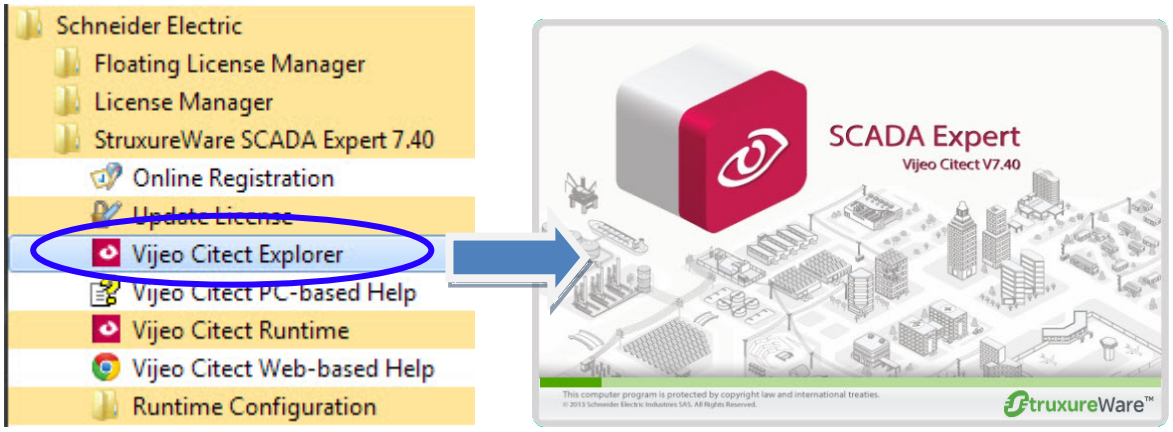
3.1 Vijeo Citect

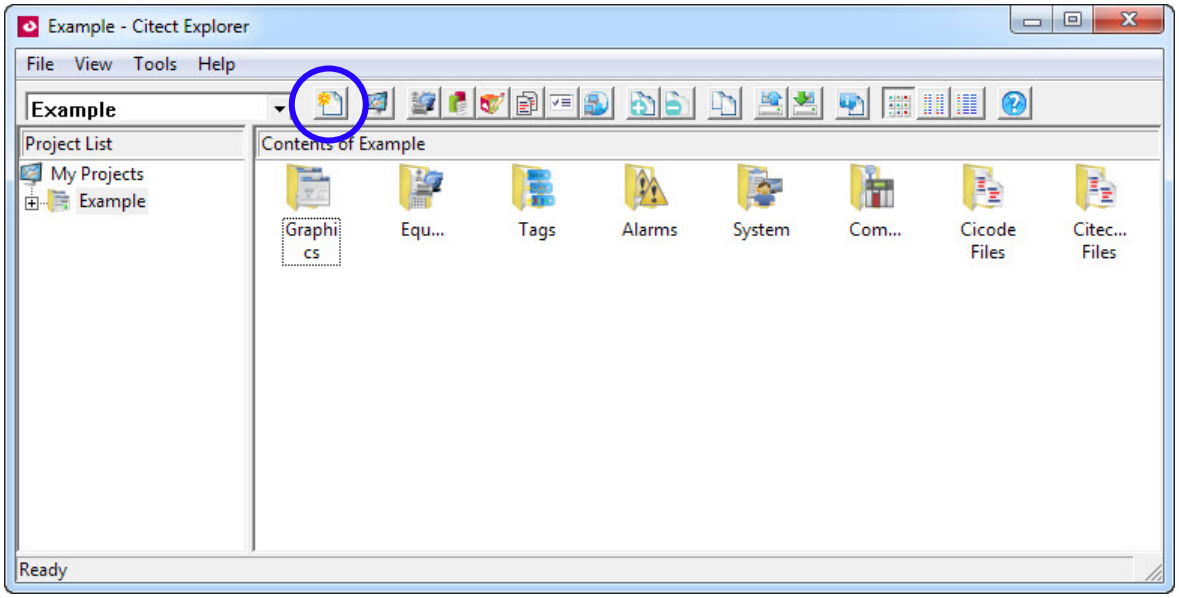
In this section, a detailed description of the procedure for connecting the Vijeo Citect solution to controller via the Modbus/TCP protocol is presented. In this example Vijeo Citect version 7.40 is used.

3.1.1. Creating a New Project, an I/O Server and an I/O Device

Step 1: Open the Vijeo Citect Explorer Software from the Startup Menu.



Step 2: In the "Citect Explorer" window, click the "New" icon to create a new project.



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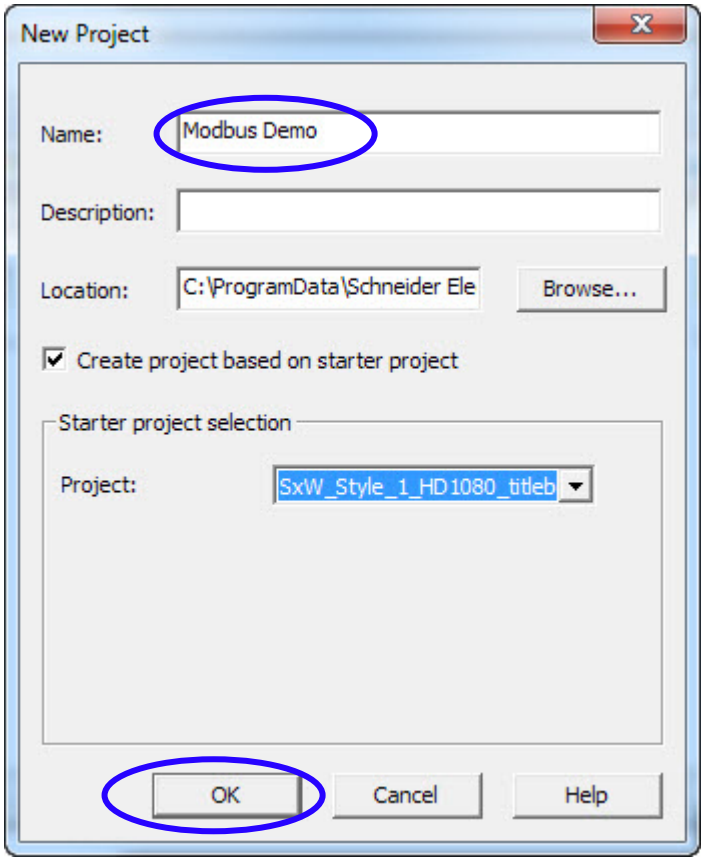
Step 3: In the “New Project” dialog box, enter a name for this project. The name “Modbus Demo” is used in this example. Leave all other parameters at their default values, and then click the “OK” button to continue.



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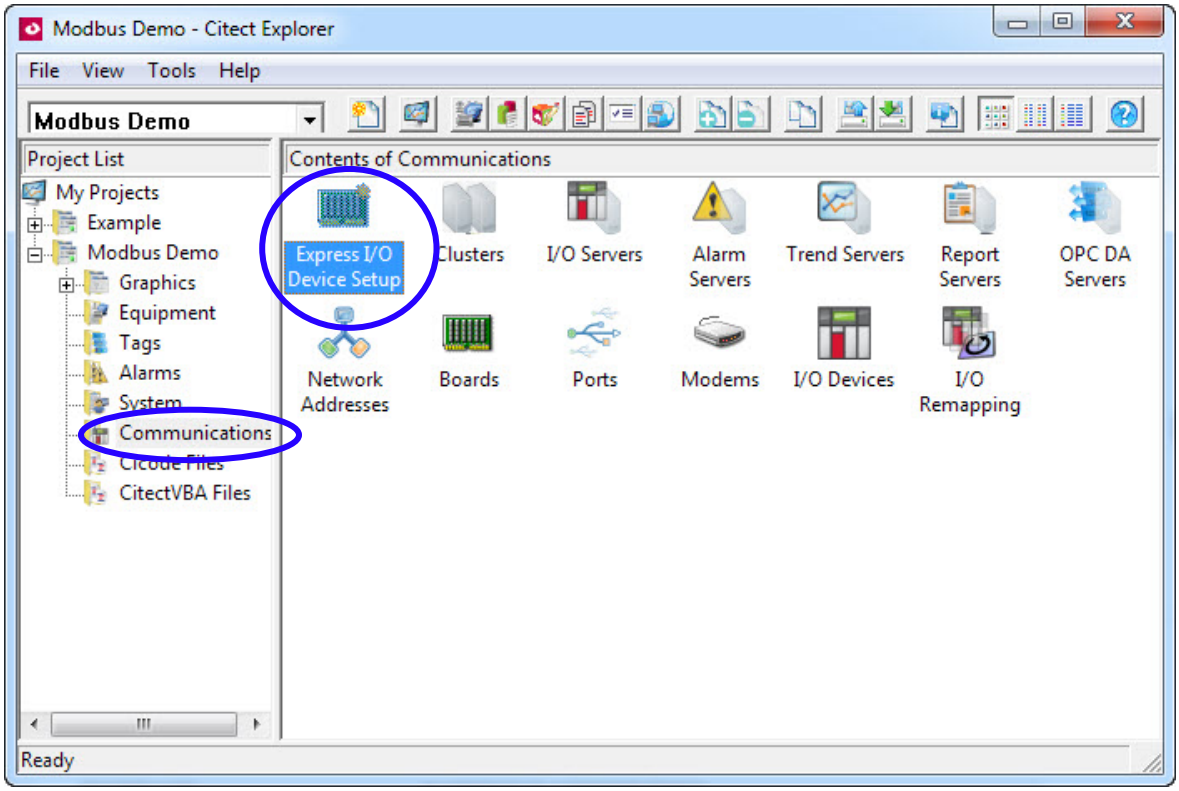
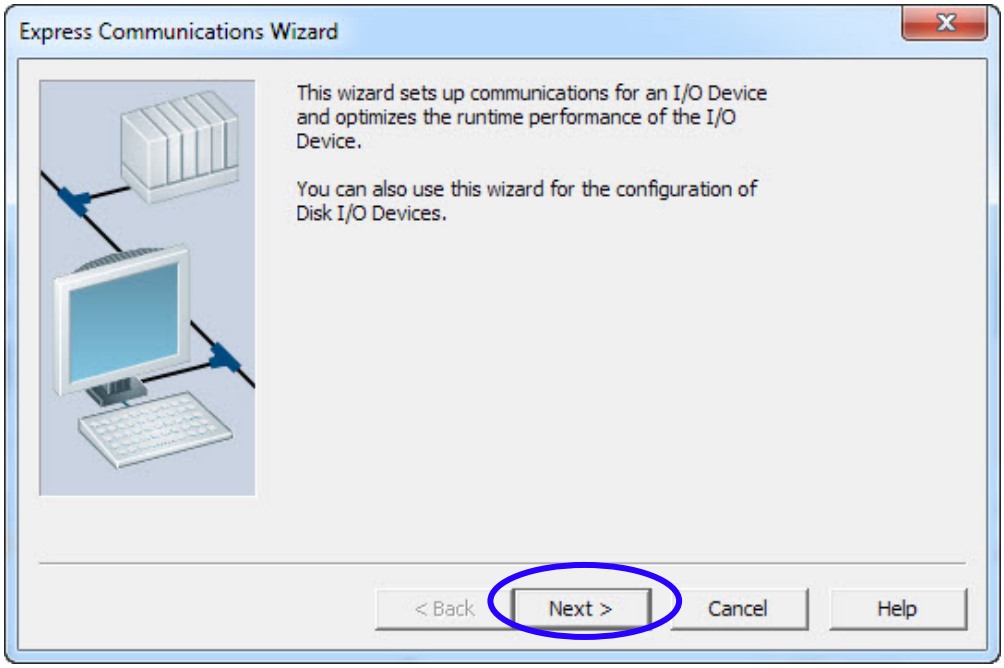
Step 4: In the Project List panel, expand the "Modbus Demo" folder, and then double-click the "Express I/O Device Setup" icon in the "Communications" folder to create a new I/O Server and I/O Device.



Step 5: Once the "Express Communications Wizard" screen is displayed, click the "Next >" button to continue.


Express Communications Wizard
This wizard sets up communications for an I/O Device and optimizes the runtime performance of the I/O Device.
You can also use this wizard for the configuration of Disk I/O Devices.
< Back
Next >
Cancel
Help

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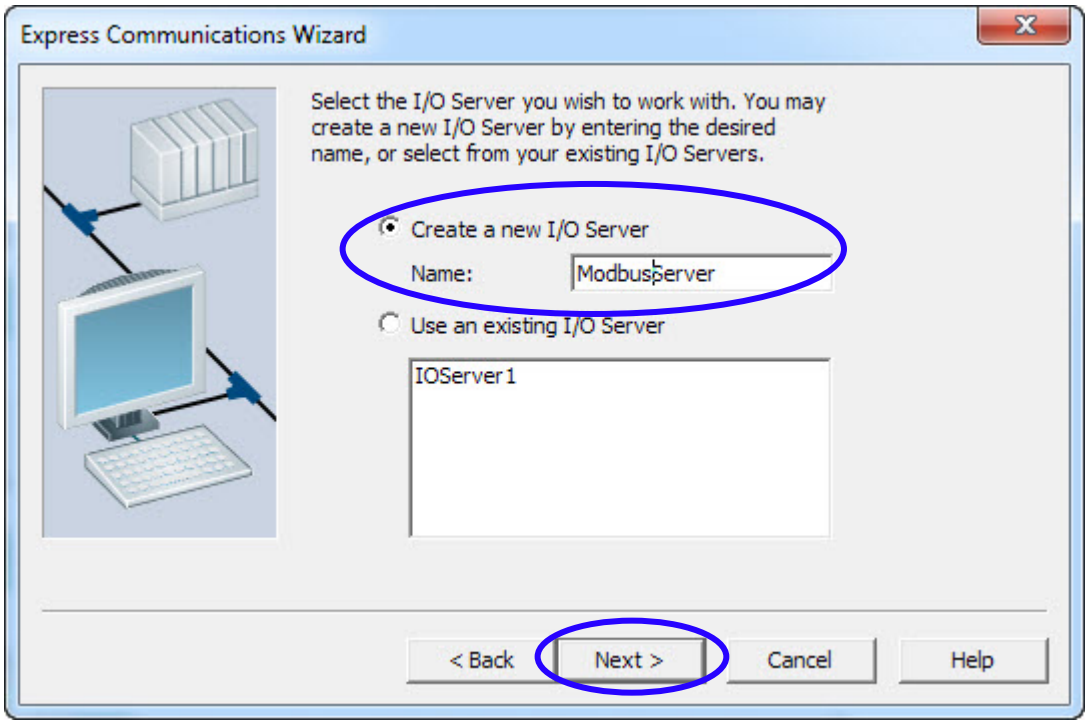
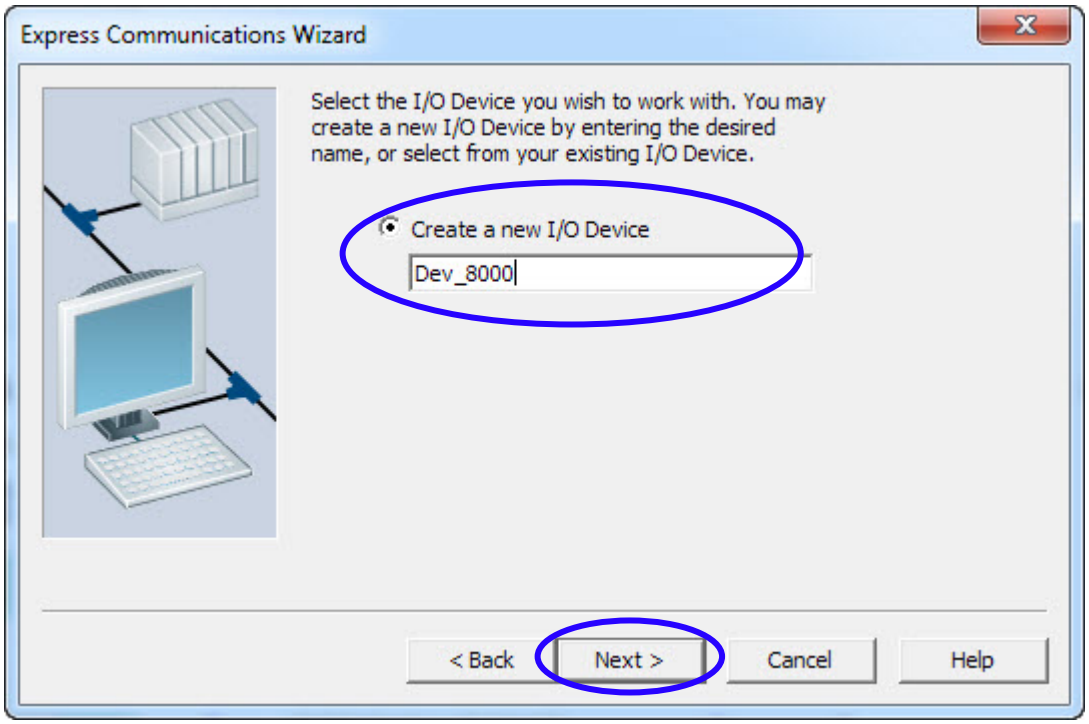
Step 6: Click the "Create a new I/O Server" radio button, and enter "ModbusServer" as the name of I/O Server in the Name field, and then click the "Next >" button to continue.


Express Communications Wizard
Select the I/O Server you wish to work with. You may create a new I/O Server by entering the desired name, or select from your existing I/O Servers.
Create a new I/O Server
Name:
Modbusserver
Use an existing I/O Server
IOServer1
< Back
Next >
Cancel
Help

Step 7: Click the "Create a new I/O Device" radio button, and enter "Dev_8000" as the name of I/O Device in the Name field, and then click the "Next >" button to continue.


Express Communications Wizard
Select the I/O Device you wish to work with. You may create a new I/O Device by entering the desired name, or select from your existing I/O Device.
Create a new I/O Device
Dev_8000
< Back
Next >
Cancel
Help

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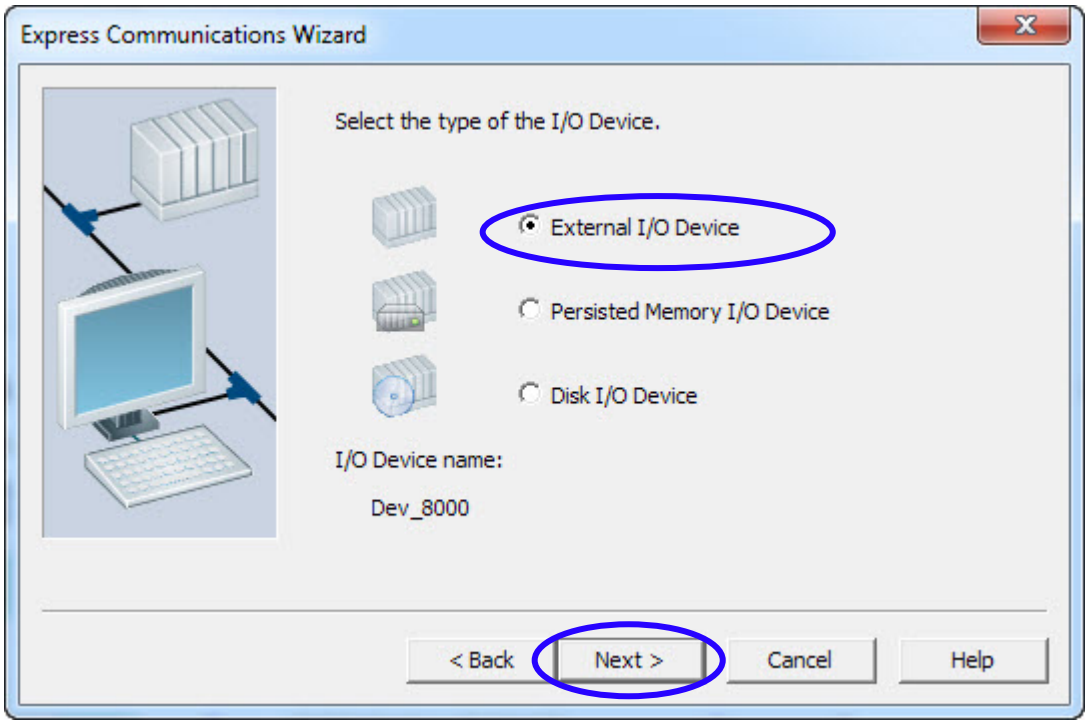
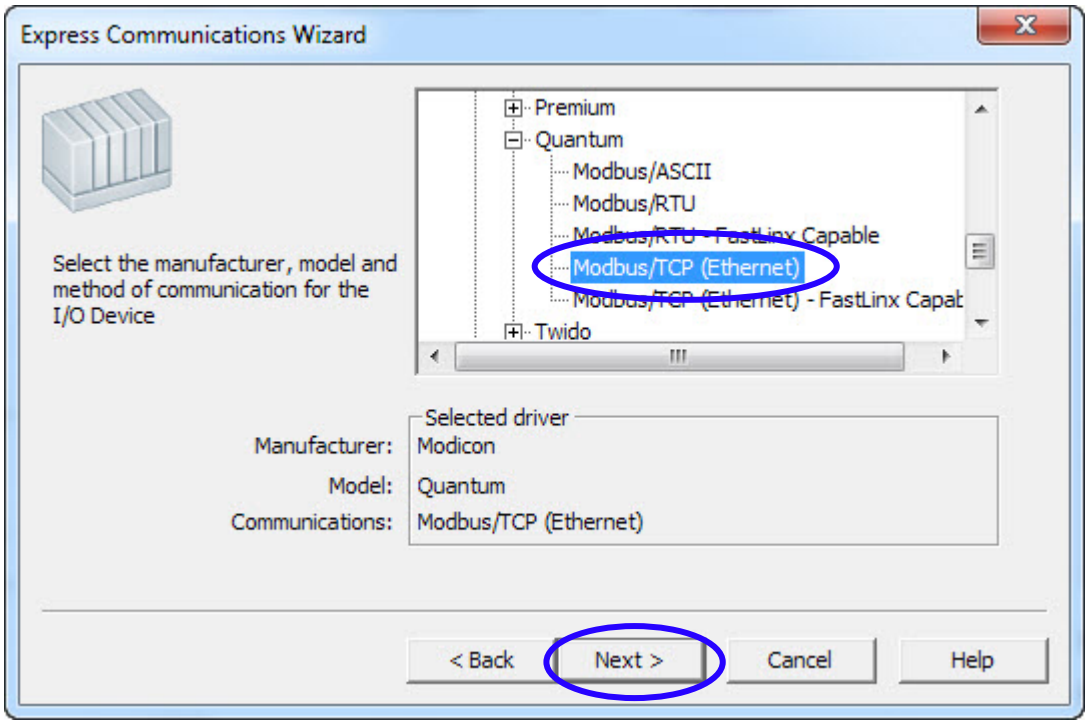
Step 8: Click the "External I/O Device" radio button to select the I/O Device type, and then click the "Next >" button to continue.



Step 9: Select the communication protocol by expanding the "Modicon" item, and then expand "Quantum" item and then click the "Modbus/TCP (Ethernet)" option. Click the "Next >" button to continue.



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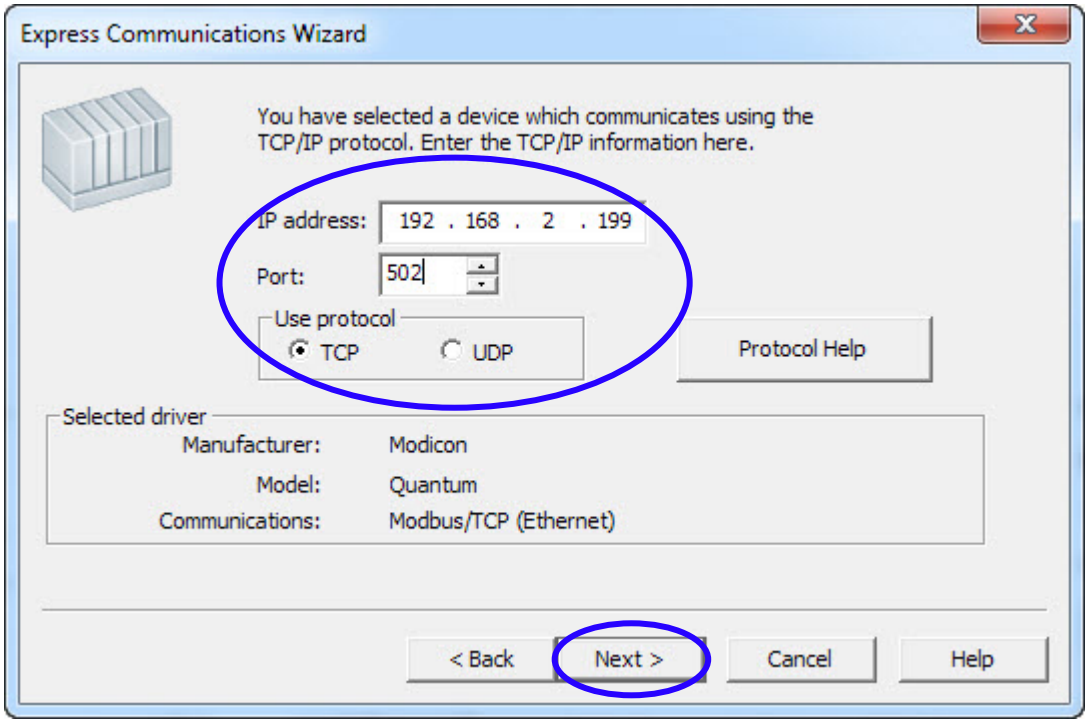
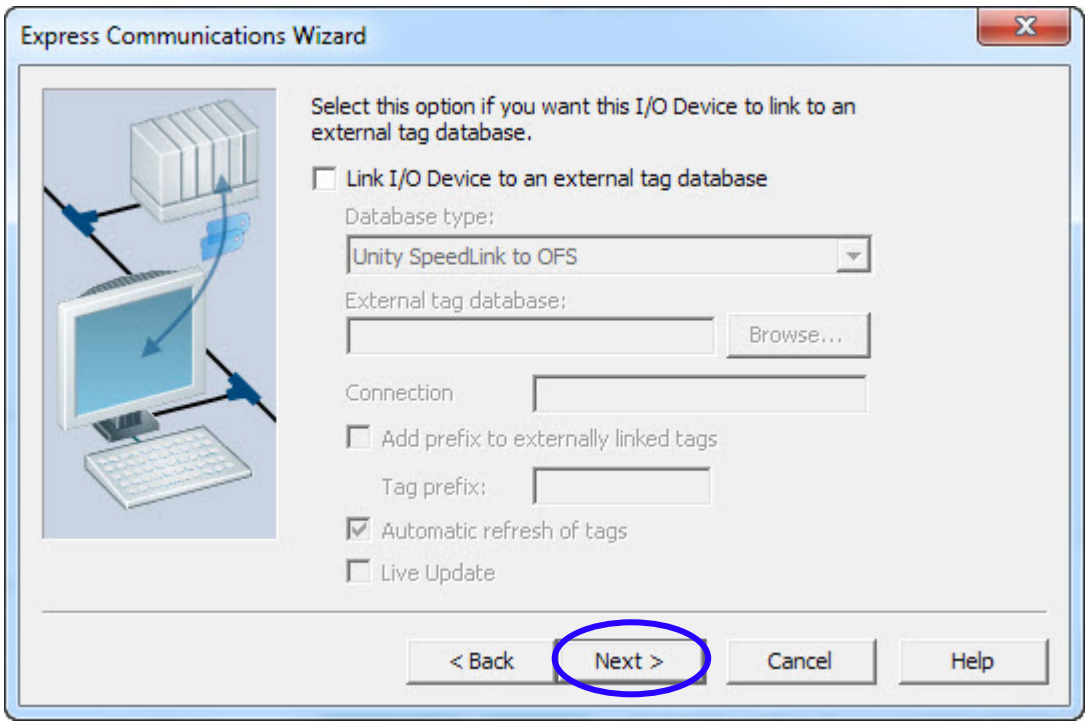
Step 10: Determine the IP address by checking the LED on the left-hand side of the controller, and enter it in the "IP address" field. In this example, the IP address "192.168.2.199" is used. Enter the Port number, "502" in this example, in the "Port" field and then click the "Next >" button to continue.



Step 11: There is no need to select any options on the following screen, so click the "Next >" button to continue.



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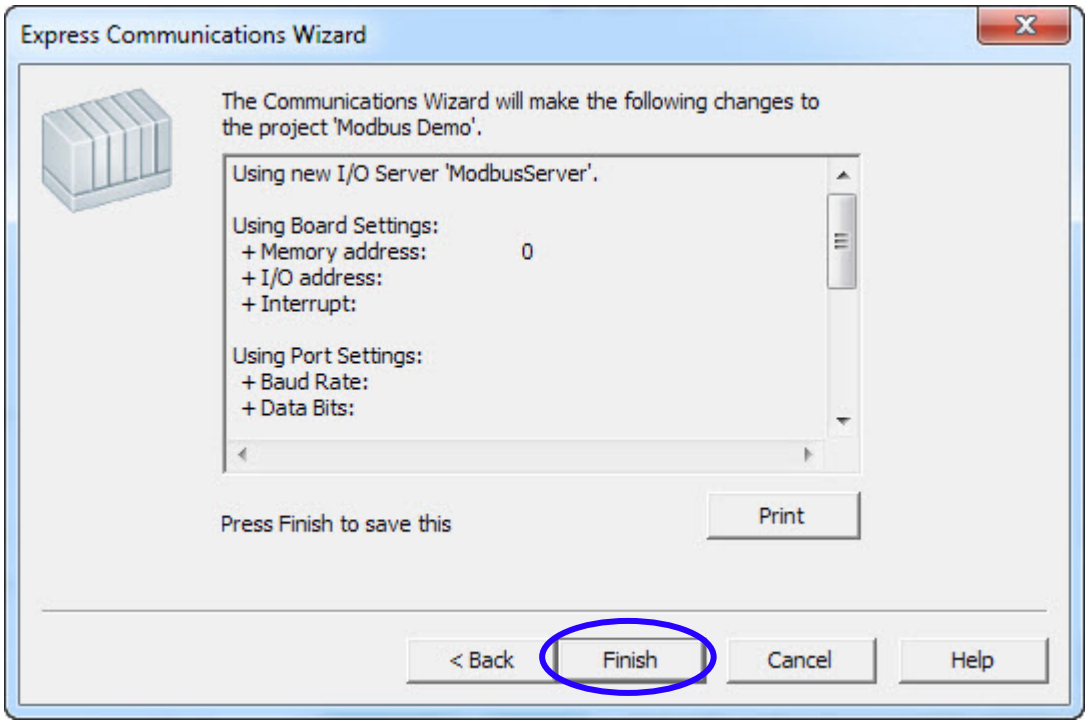
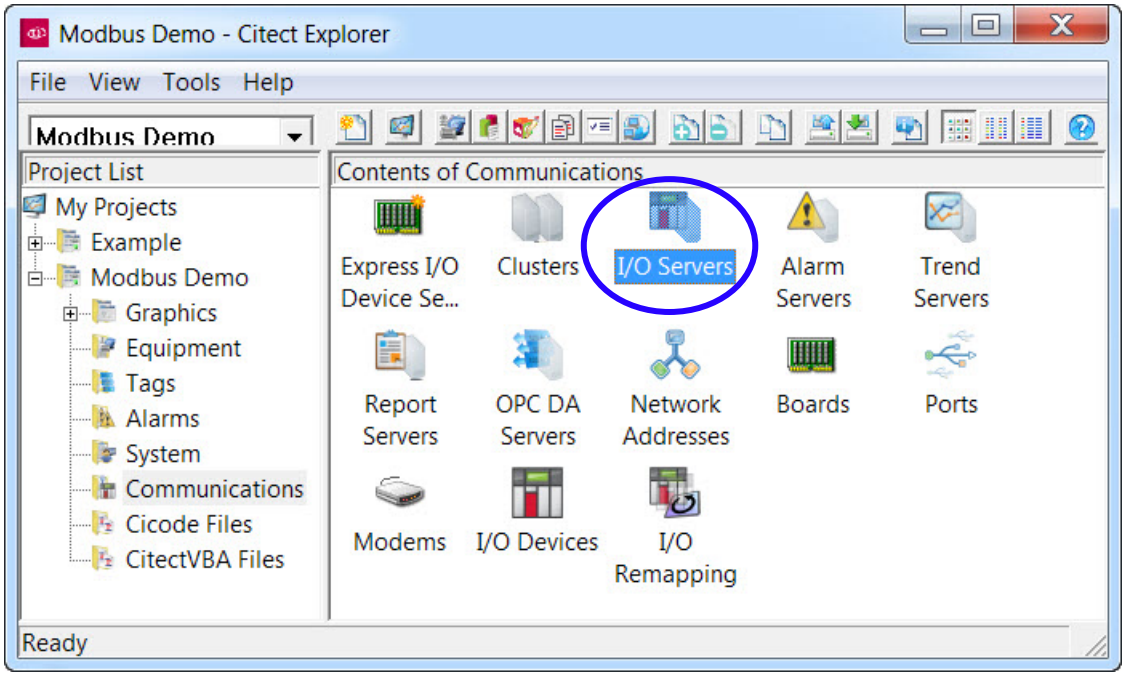
Step 12: Verify that the details for the new I/O Server are correct, and then click the "Finish" button to complete the configuration.



Step 13: Double-click the “I/O Servers” icon to open the “I/O Server [Modbus Demo]” dialog box in the “Citect Project Editor” window.



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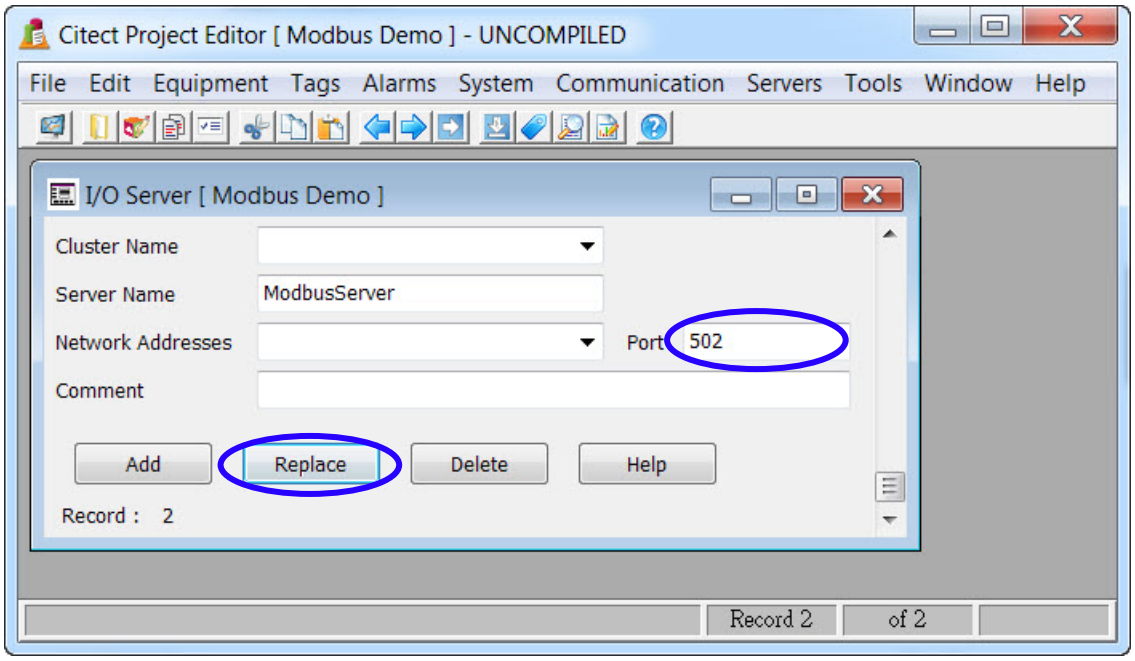
Step 14: Roll the scroll to find the Server named “ModbusServer” that was created in previous step. Enter the port number “502” in the “Port” text field and then click the “Replace” button to complete the I/O Server configuration.



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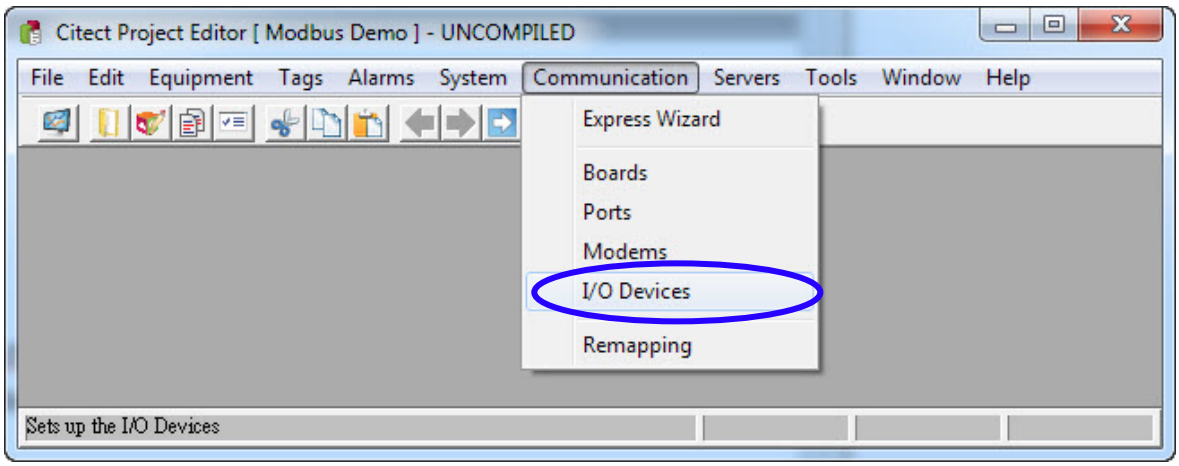
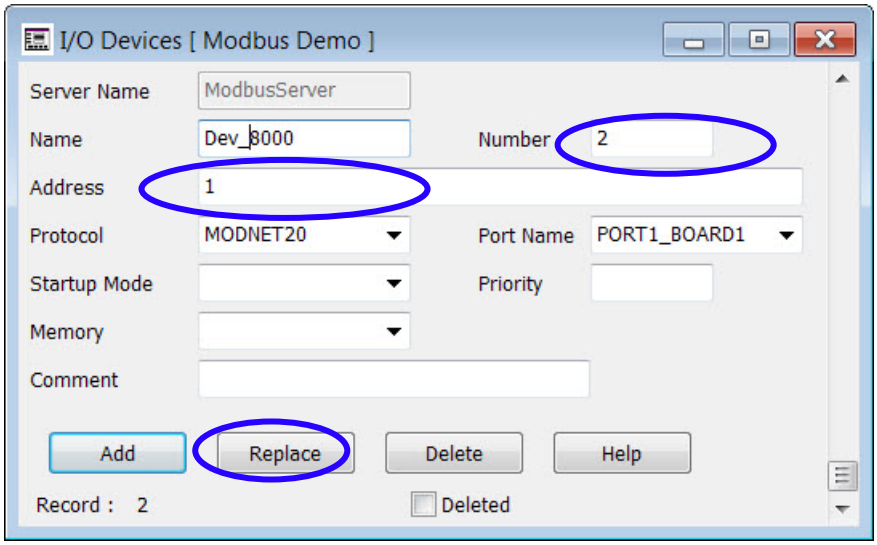
3.1.2. Designing the Layout and Acquiring the Data

Step 1: Switch the screen to the “Citect Project Editor” window, and then select the “I/O Devices” option from the Communication menu in order to modify the parameters for the I/O device that was created in Section 3.1.1.



Step 2: Once the “I/O Device [Modbus Demo]” dialog box is displayed, roll the scroll to find the device named “Dev_8000” that was created in Section 3.1.1. Determine the station number by checking the DIP switch on the right-hand side of the controller, and enter the value in the "Address" field. In this example, the station number "1" is used. To prevent the “Number” was the same with the exist Server Number, enter “2” in the “Number” field. When all settings are finished, click the "Replace" button to complete the configuration.



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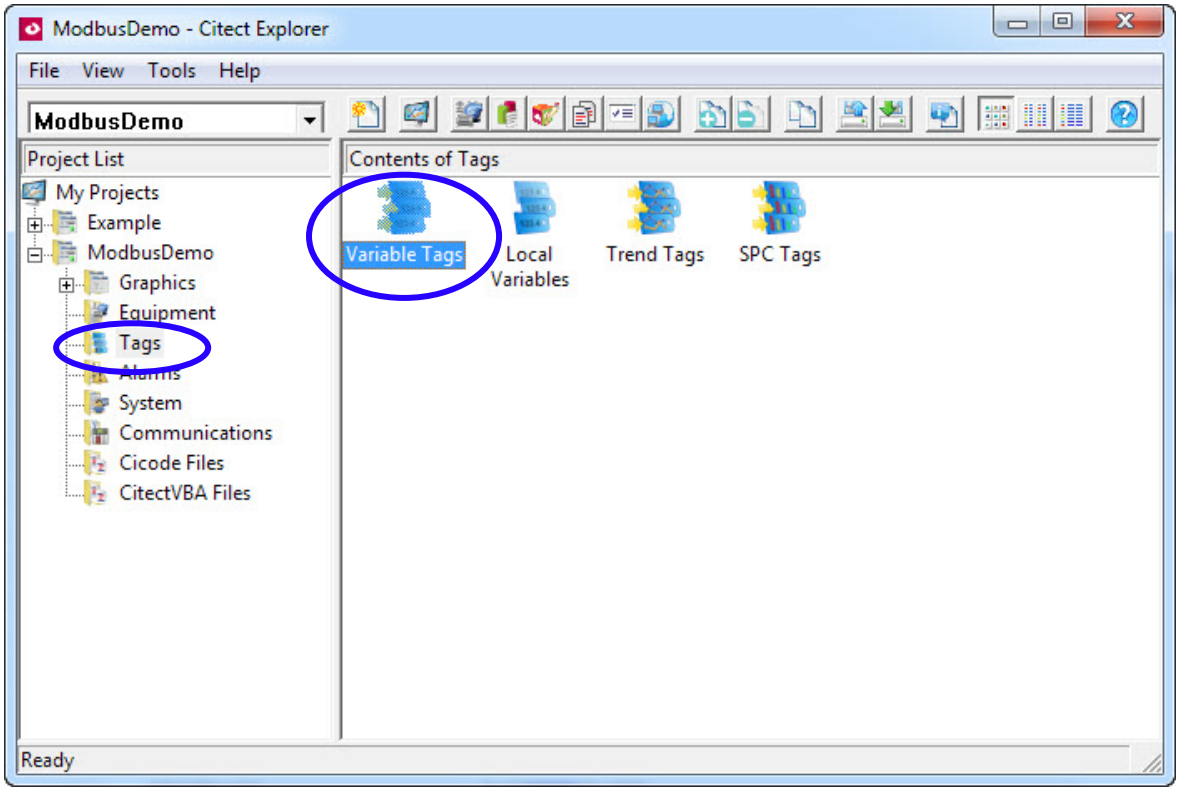
Step 3: Switch the screen to the “Citect Explorer” window, expand the “Modbus Demo” folder in the Project List panel. Double-click the “Variable Tags” icon in the Tags folder to create a new variable tags.



Step 4: Switch the screen to the “Citect Project Editor” window, enter a name for the tag in the “Tag Name” field in the “Variable Tags [Modbus Demo]” dialog box. Then select the device from the “I/O Device” drop-down menu, enter the correct address in the "Address" field, and select the appropriate "Data Type" from the drop-down menu. After the details for the first tag have been entered, click the "Add" button to save it, and then repeat the procedure to create the next tag. The parameters for all tags used in this example are shown in the table below.

Tag Name	I/O Device Name	Data Type	Address	Eng Scale
DO_0	Dev_8000	DIGITAL	00001	X
DI_0	Dev_8000	DIGITAL	10001	X
AO_0	Dev_8000	INT	40001	0~10
AI_0	Dev_8000	INT	30001	0~10

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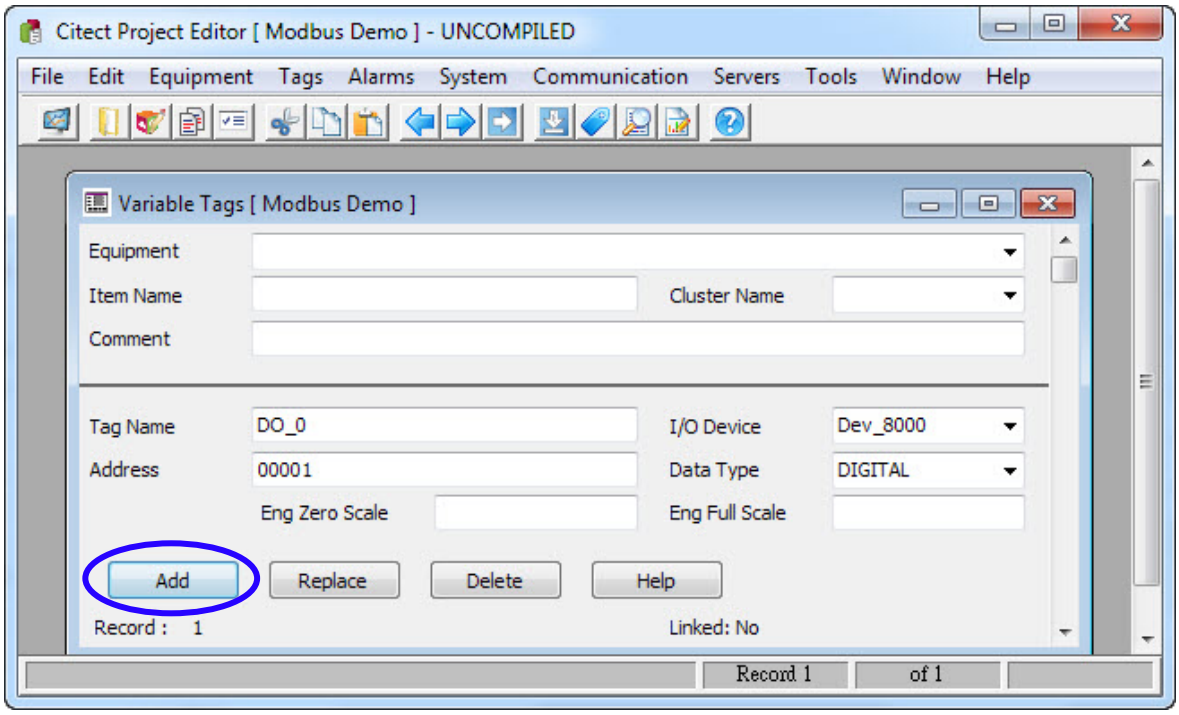

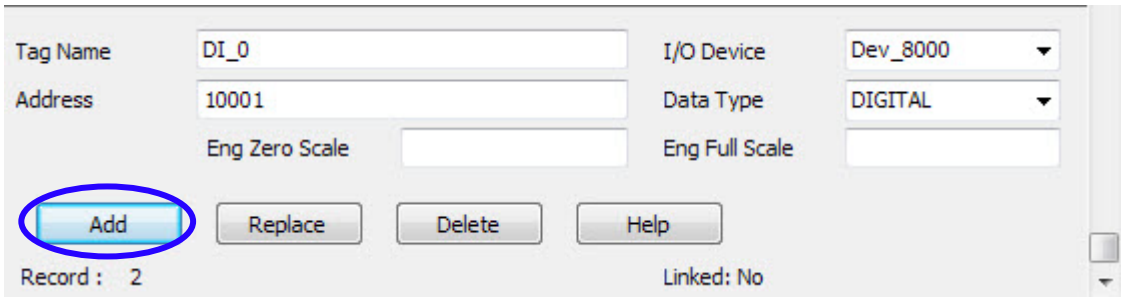

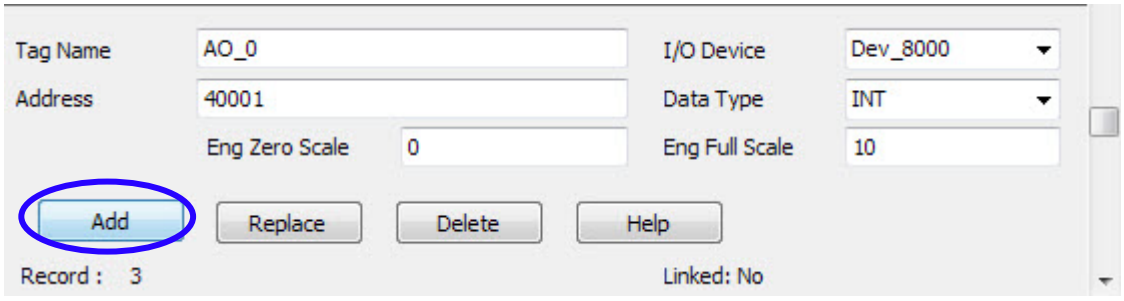

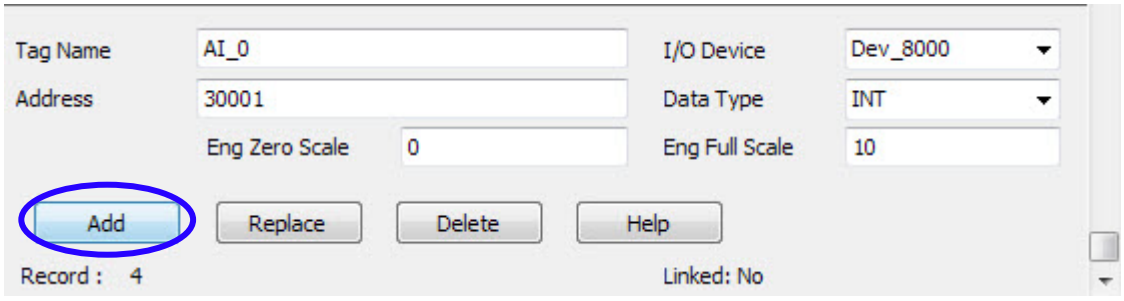

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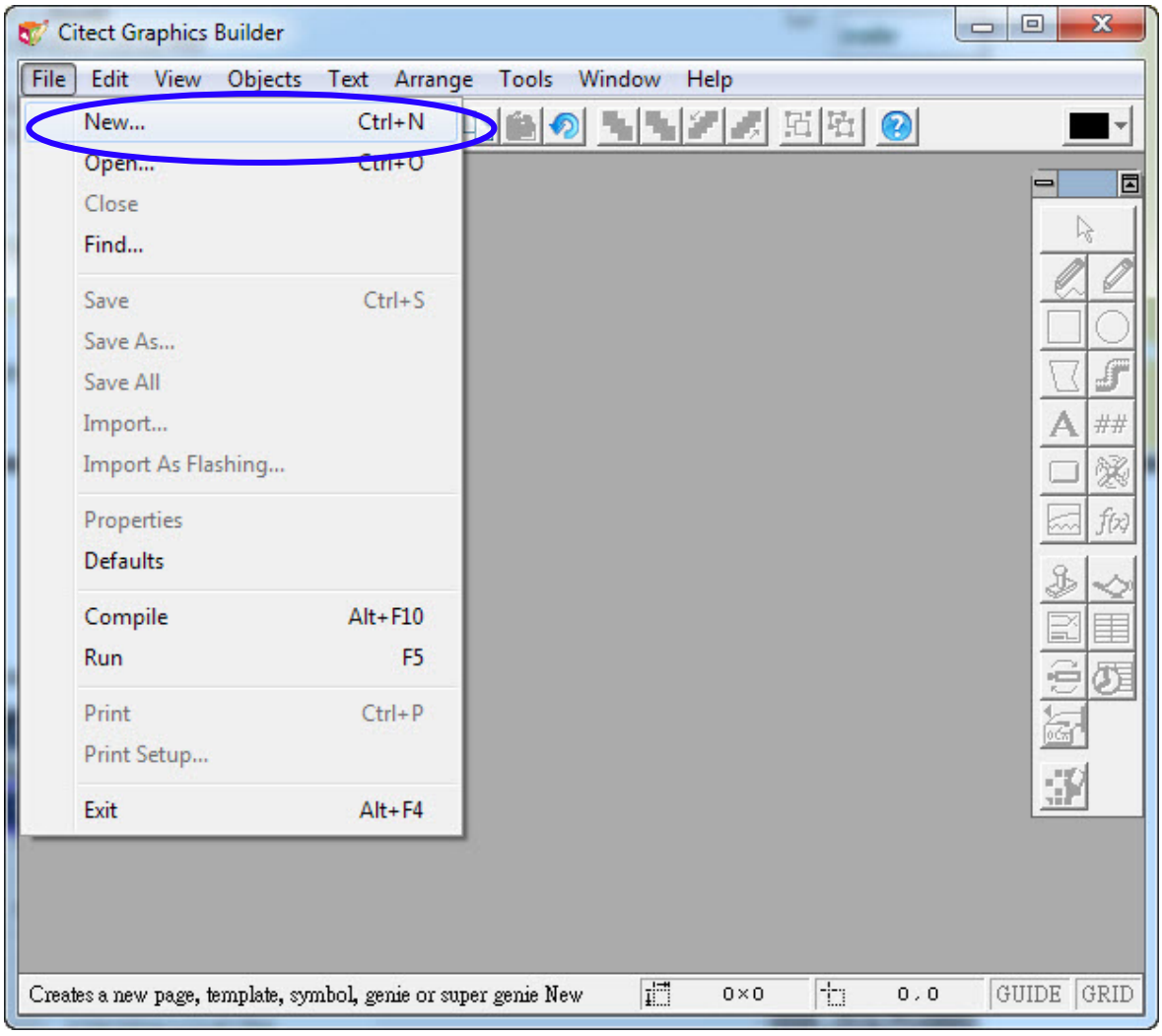
Notes

- When using the Modbus protocol, the Address Type must be set to “0xxxx” for Digital Output, “1xxxx” for Digital Input, “3xxxx” for Analog Input, and “4xxxx” for Analog Output.
- The Digital Input and Digital Output are declared as Boolean data, and the Analog Input and Analog Output are declared as unsigned integer data.
- The “Starting Address” begins at “0001”. Thus, to use the 5th Digital Output, the “Address” filed must be se to “10005”, and the Data Type must be set to “DIGITAL”. To use the 15th Analog Input, enter “30015” in the “Address” field, and set the Data Type to “INT”.

Step 5: Switch the screen to the “Citect Graphics Builder” window, click “New…” from the “File” menu to create a new page.



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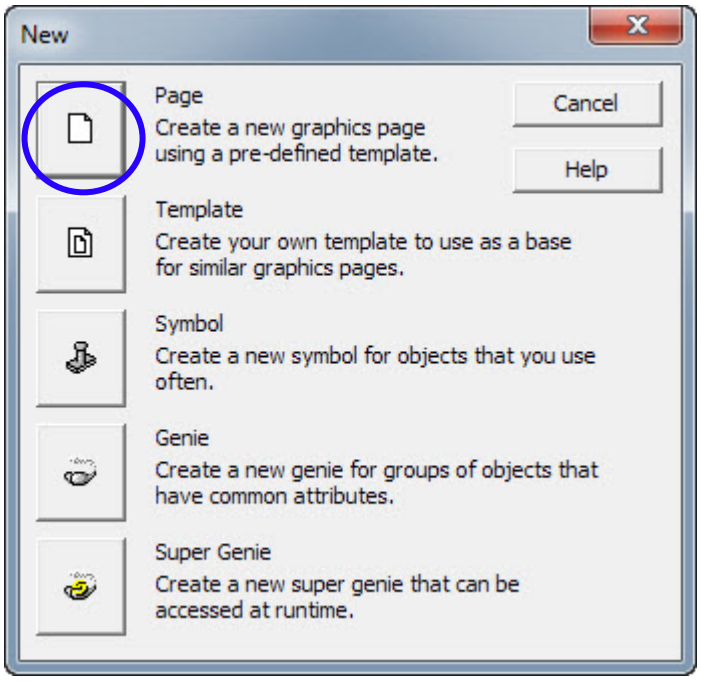
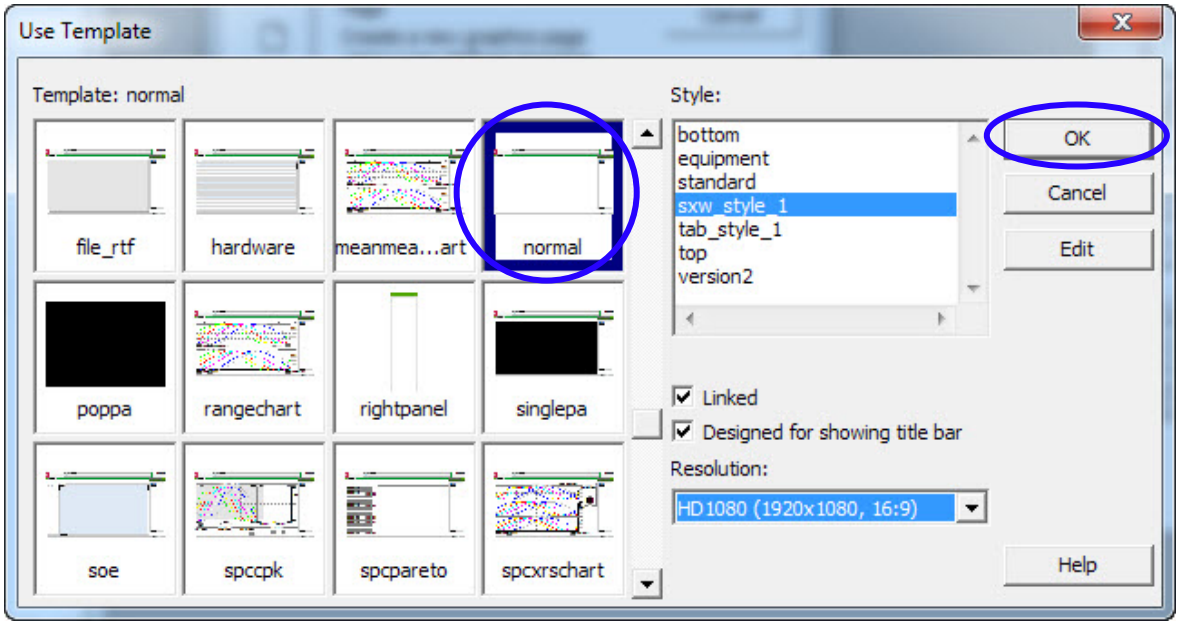
Step 6: In the "New" dialog box, click the "Page" button to create a new page using a pre-defined template.


New
Page
Create a new graphics page using a pre-defined template.
Cancel
Help
Template
Create your own template to use as a base for similar graphics pages.
Symbol
Create a new symbol for objects that you use often.
Genie
Create a new genie for groups of objects that have common attributes.
Super Genie
Create a new super genie that can be accessed at runtime.

Step 7: In the "Template" dialog box, click the "normal" option to select the template to be used for the page, and then click the "OK" button to continue.



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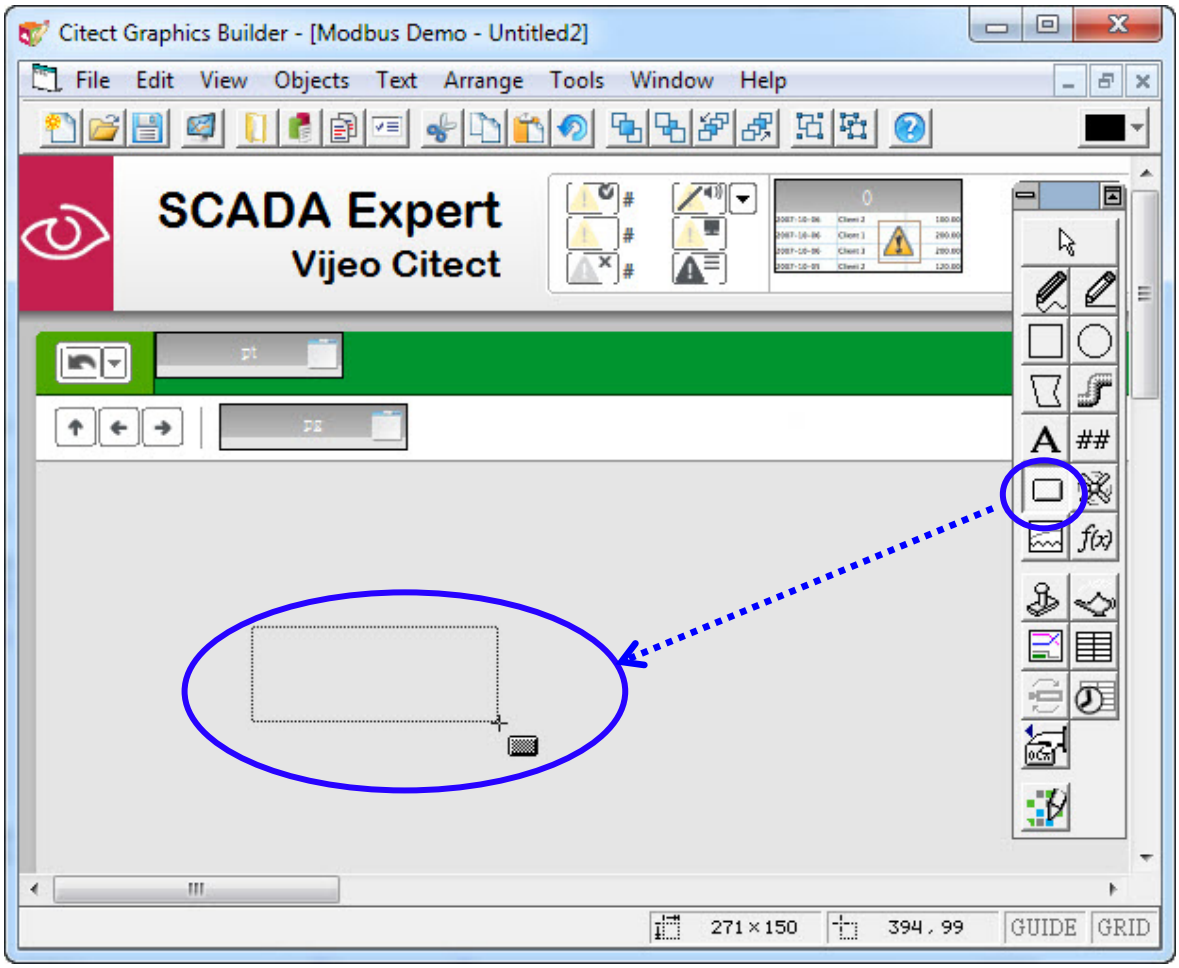
Step 8: Click and hold the "New Button" icon and then drag-and-drop it onto the blank page to add a new button to the page.



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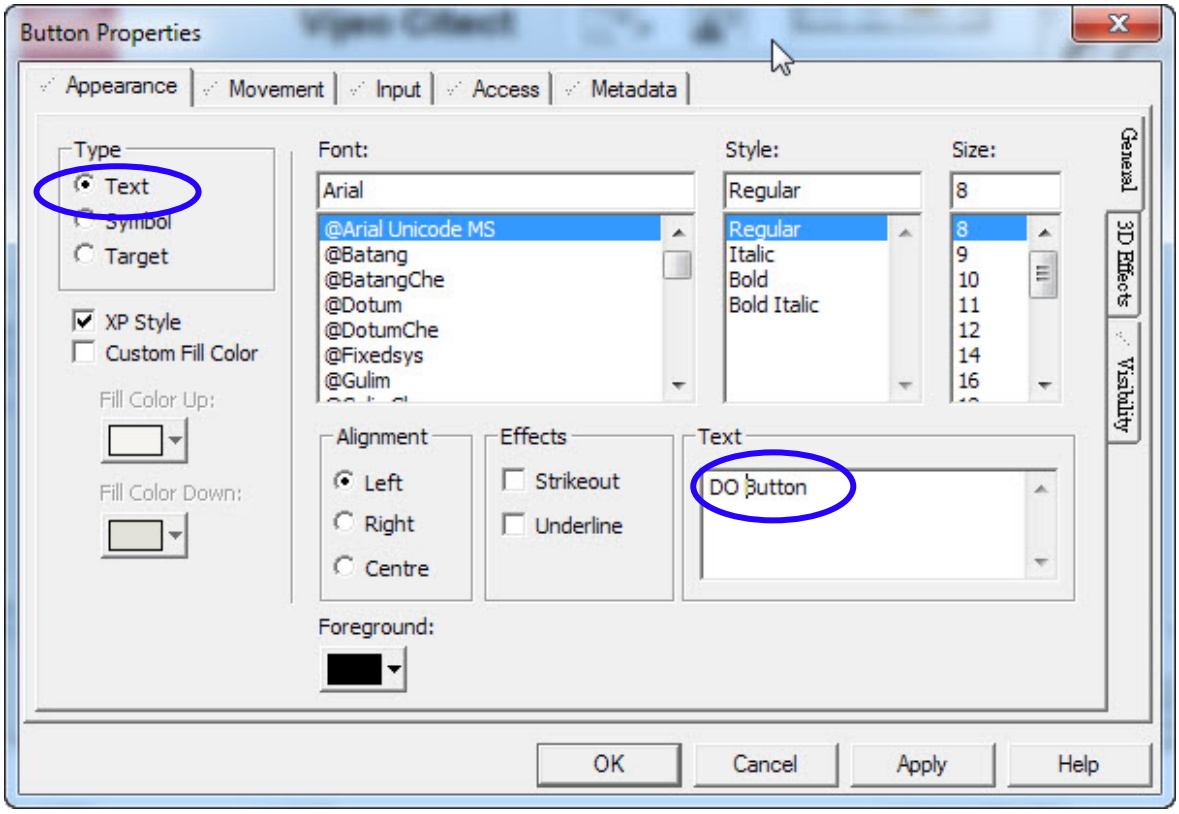
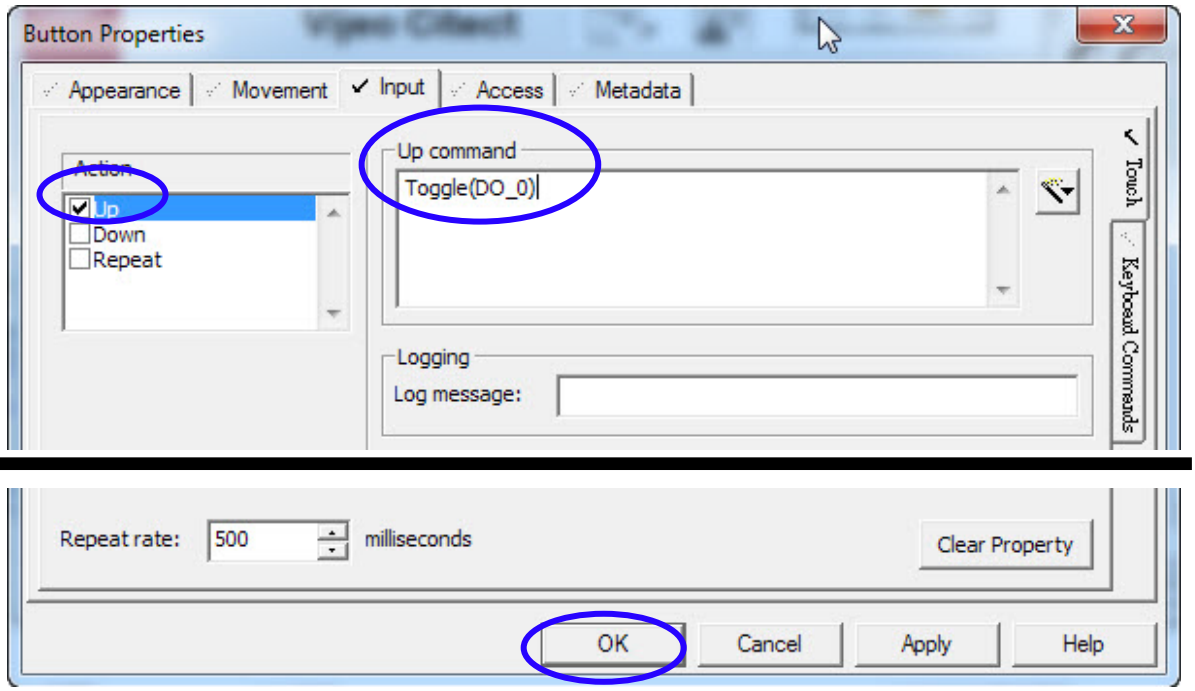
Step 9: Once release the cursor, the “Button Properties” dialog box will be displayed. Click the "Appearance" tab and click the "Text" radio button and enter "DO Button" in the "Text" field. This will be the label displayed on the button. Click the "Input" tab and check the "Up" checkbox then enter "Toggle(DO_0)" in the "UP Command" text field. Click the "OK" button to save the changes.





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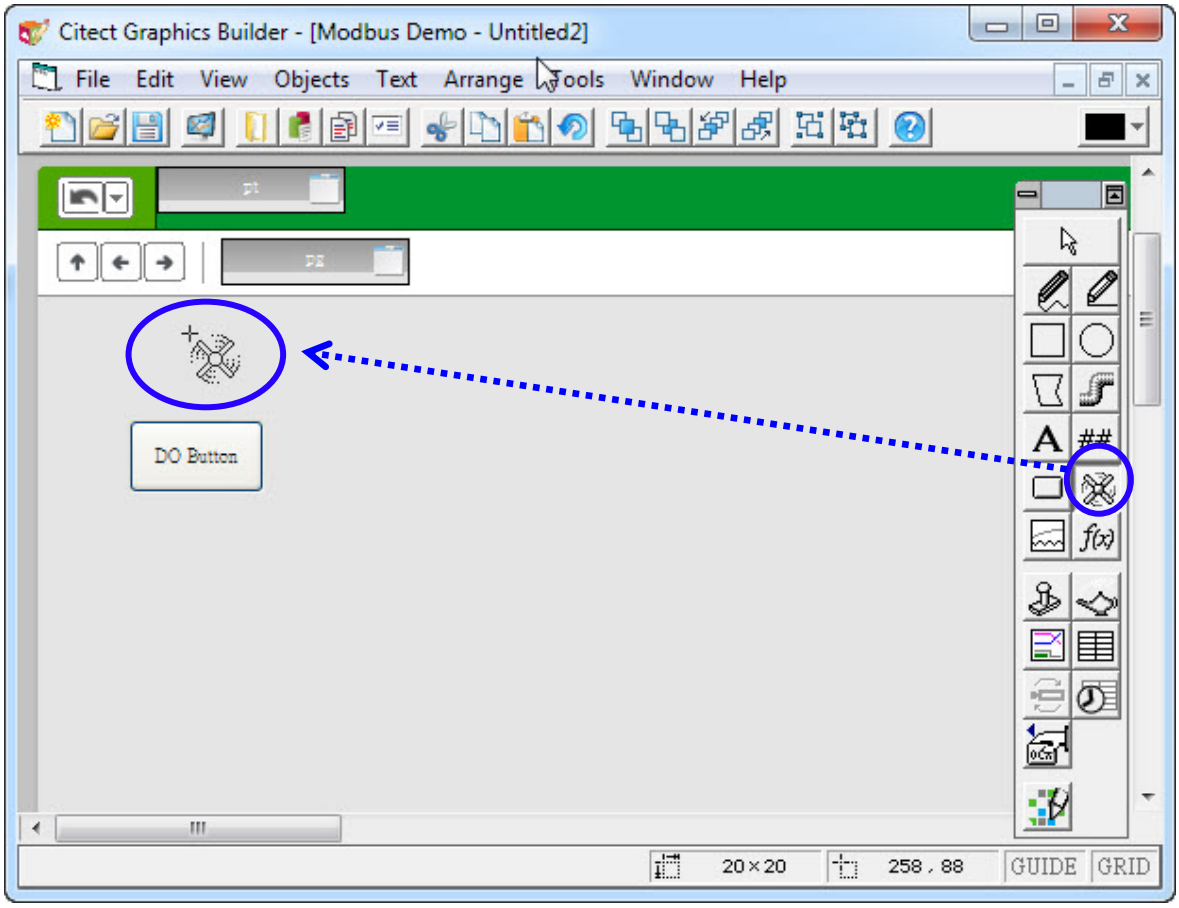
Step 10: Click and hold the "LED Object" icon and then drag-and-drop it onto the page to add a new LED object to the page.



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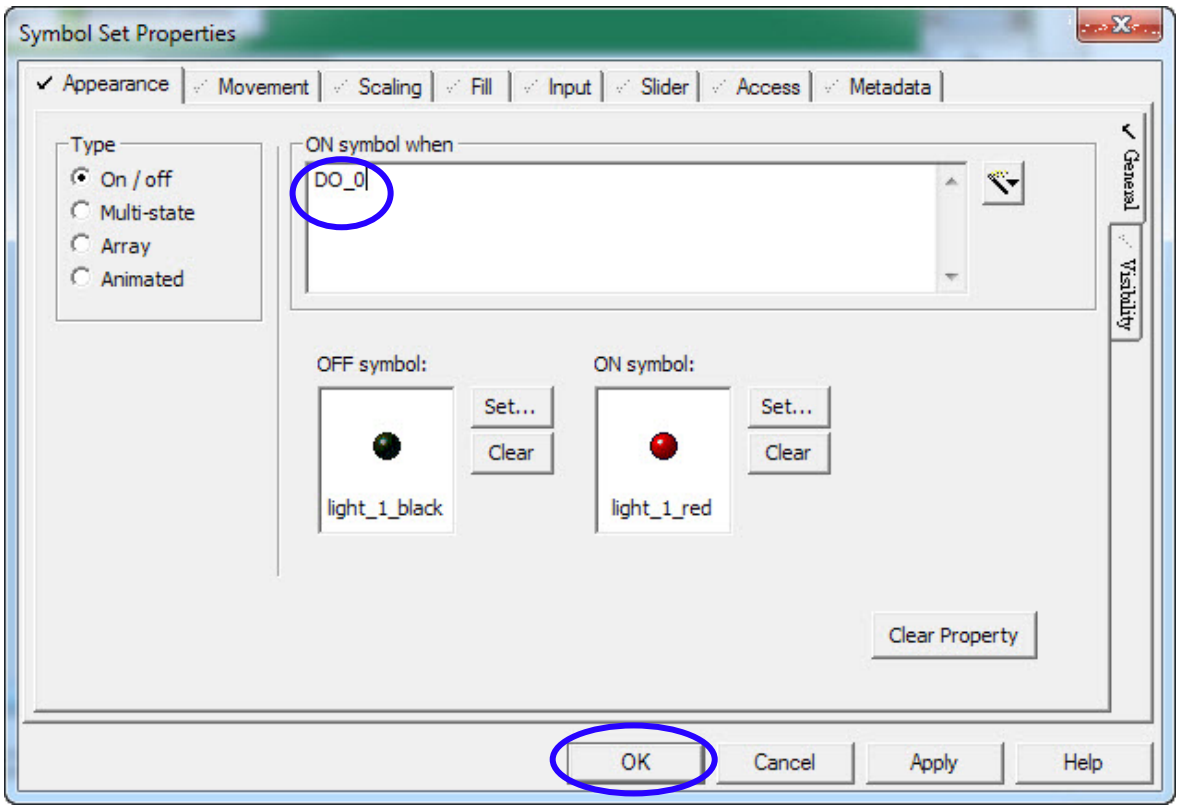
Step 11: Once release the cursor, the “Symbol Set Properties” dialog box will be displayed. Click the "Appearance" tab and click the "On/Off" radio button in the "Type" section, then enter "DO_0" in the "ON symbol when" text field. Click the "OK" button to save the changes.



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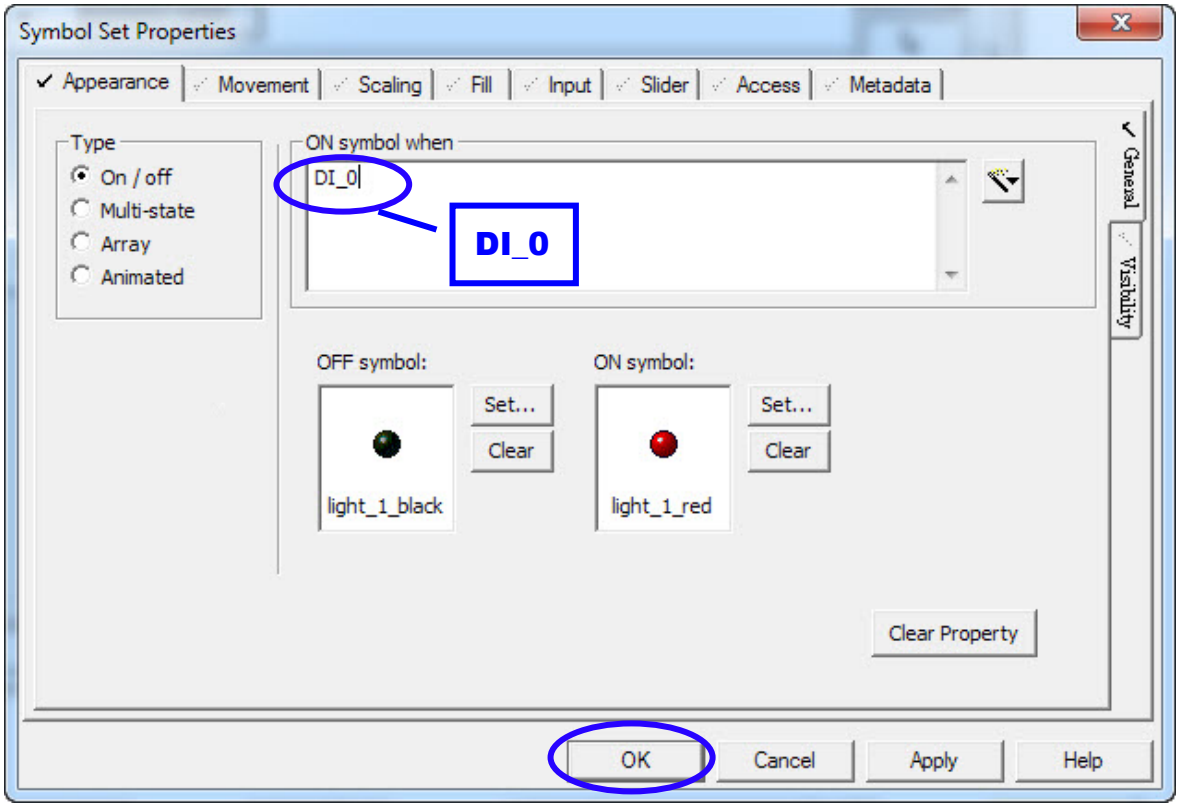
Step 12: Repeat Steps 10 and 11 to create a second LED object. Use the parameters shown in the image below for this LED object.



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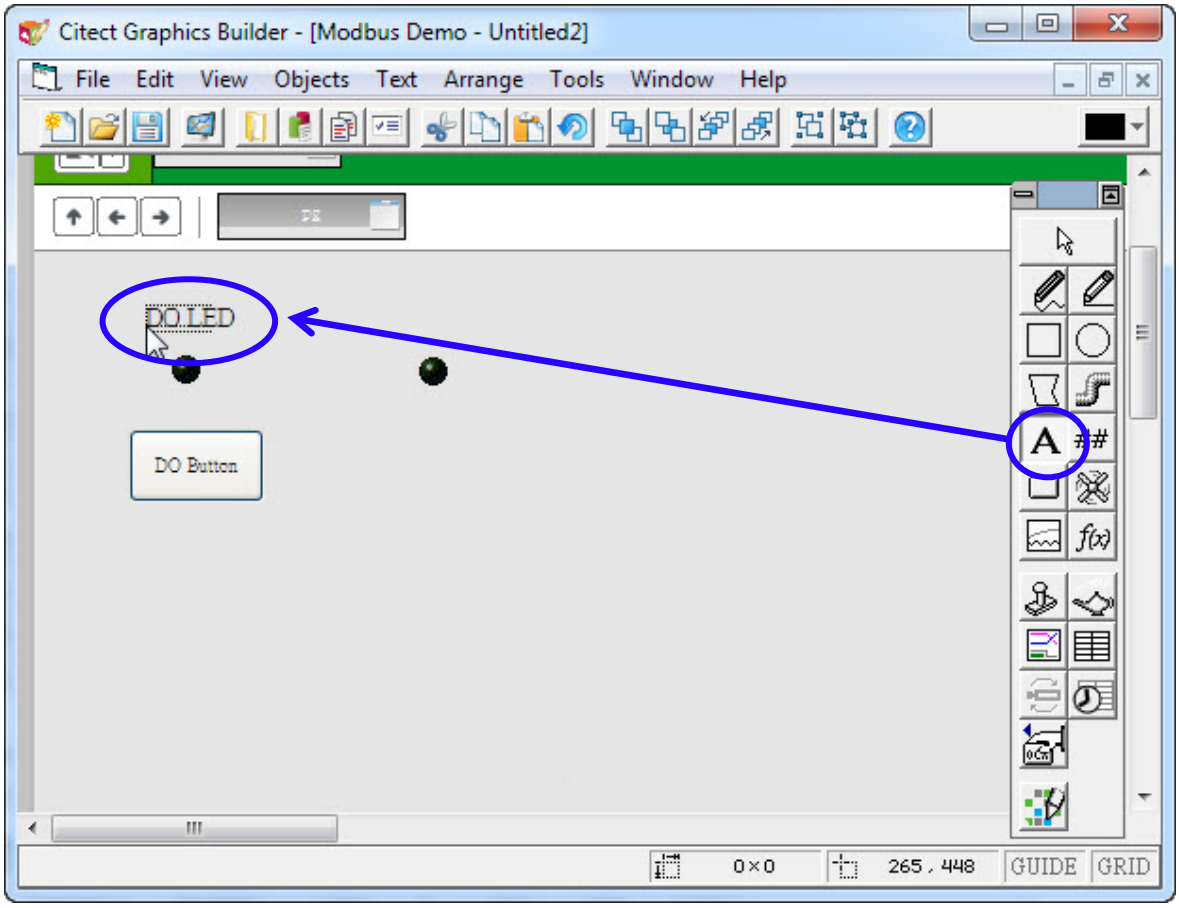
Step 13: Click the "Text" icon and then move the cursor onto the page above the left-hand LED object, and enter “DO LED” to the text field.



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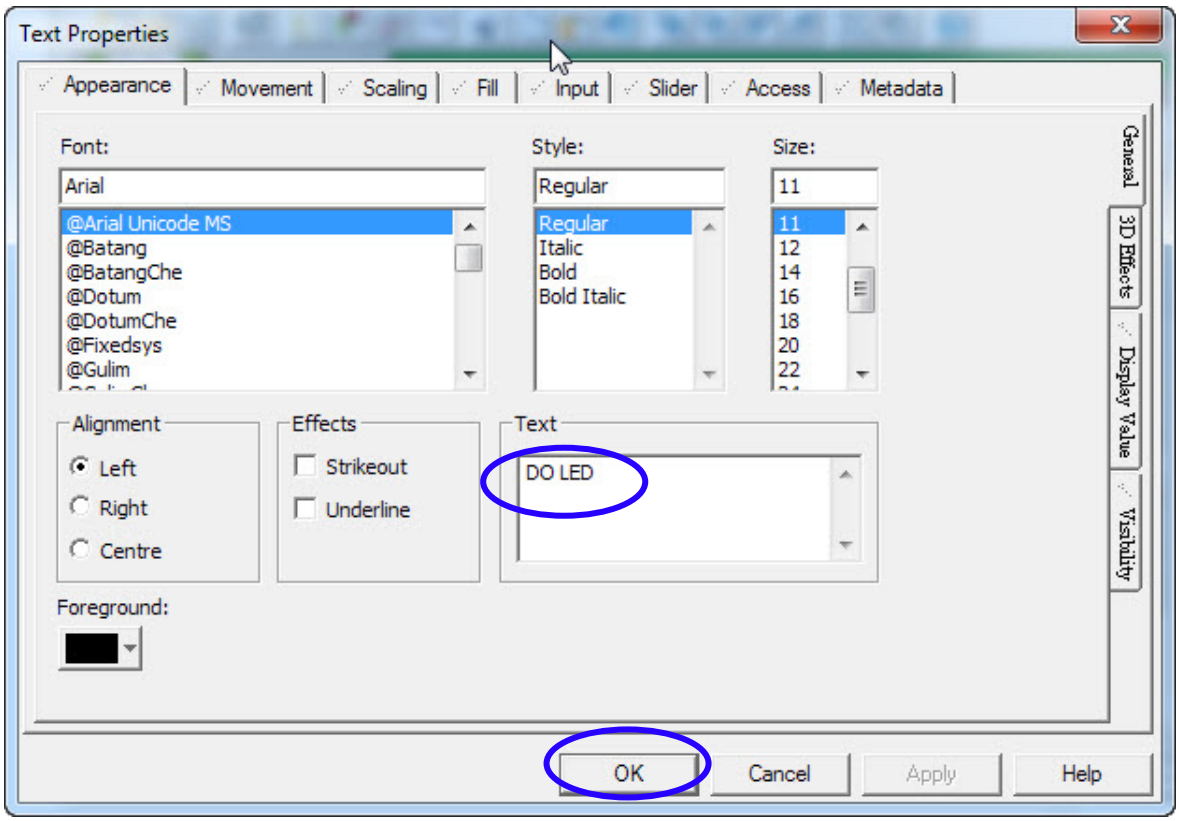
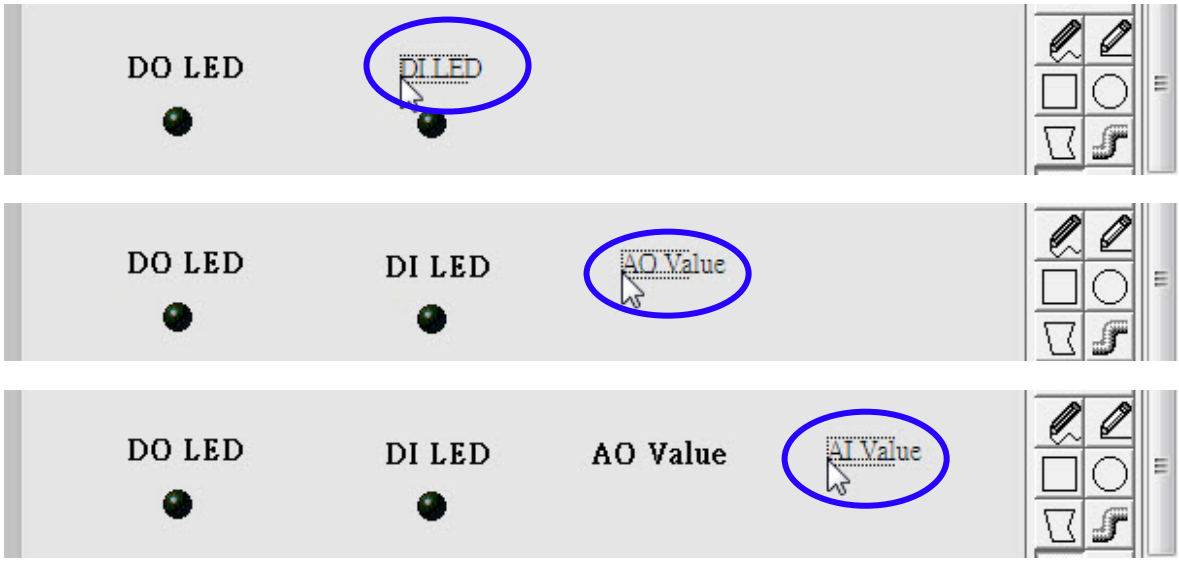
Step 14: Once finishing entering the Text, click the text again and the "Text Properties" dialog box will be displayed. Verify the words in the "Text" field, and then click the "OK" button to save the settings.



Step 15: Follow the Steps 13 and 14 to create three more Text objects and place them in the appropriate locations. Use the parameters shown in the image below for these Text objects.



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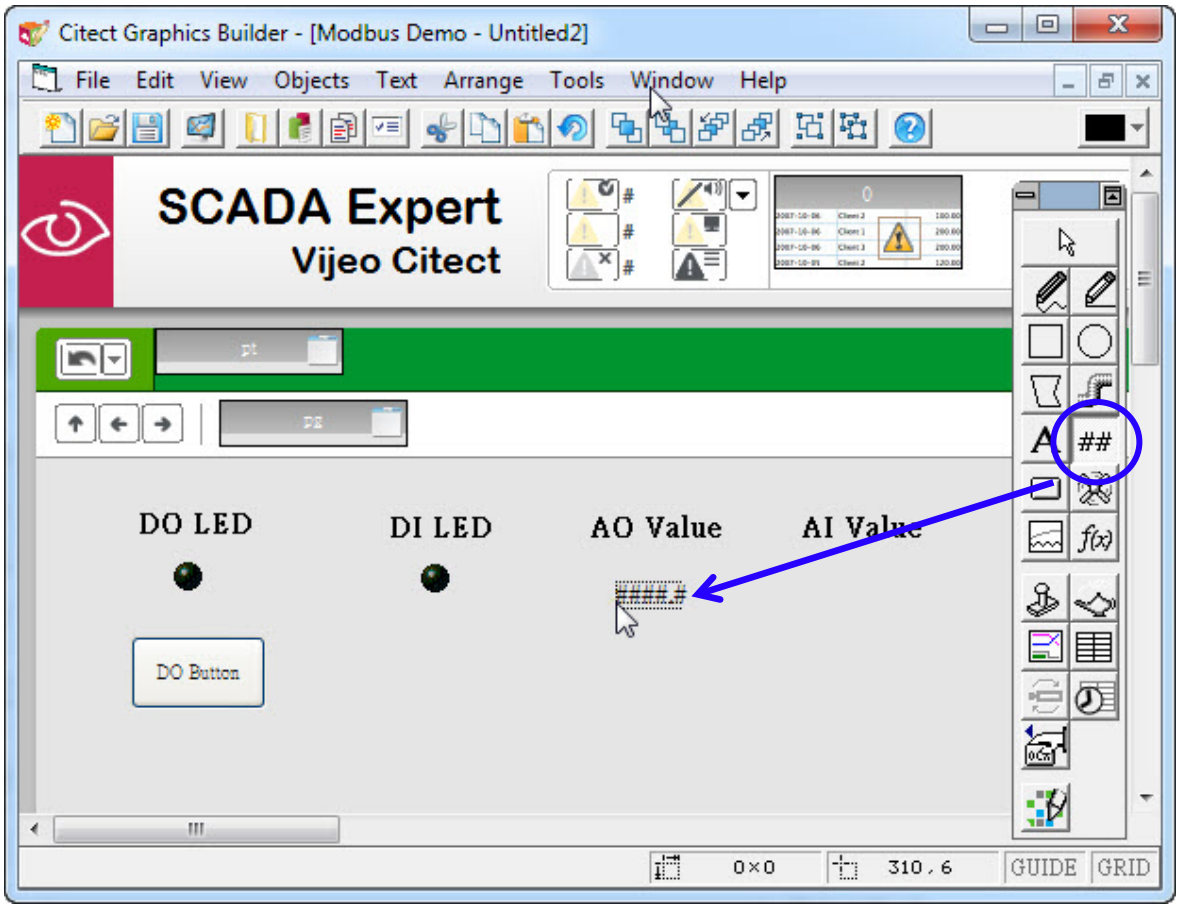
Step 16: The layout of the page at this stage is shown in the image below. Click and hold the "Number" icon and then move it onto the page below the "AO Value" text object to create a new number object.



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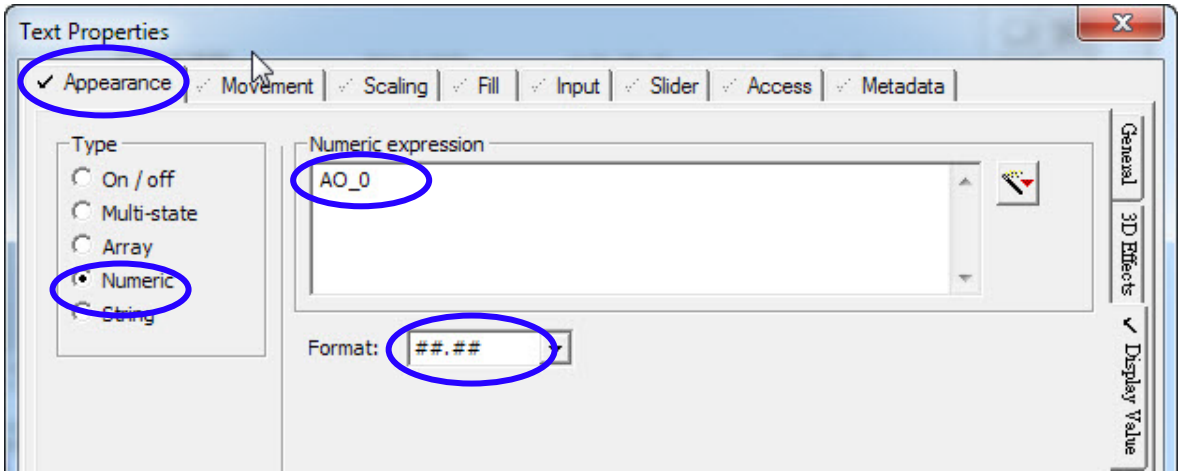
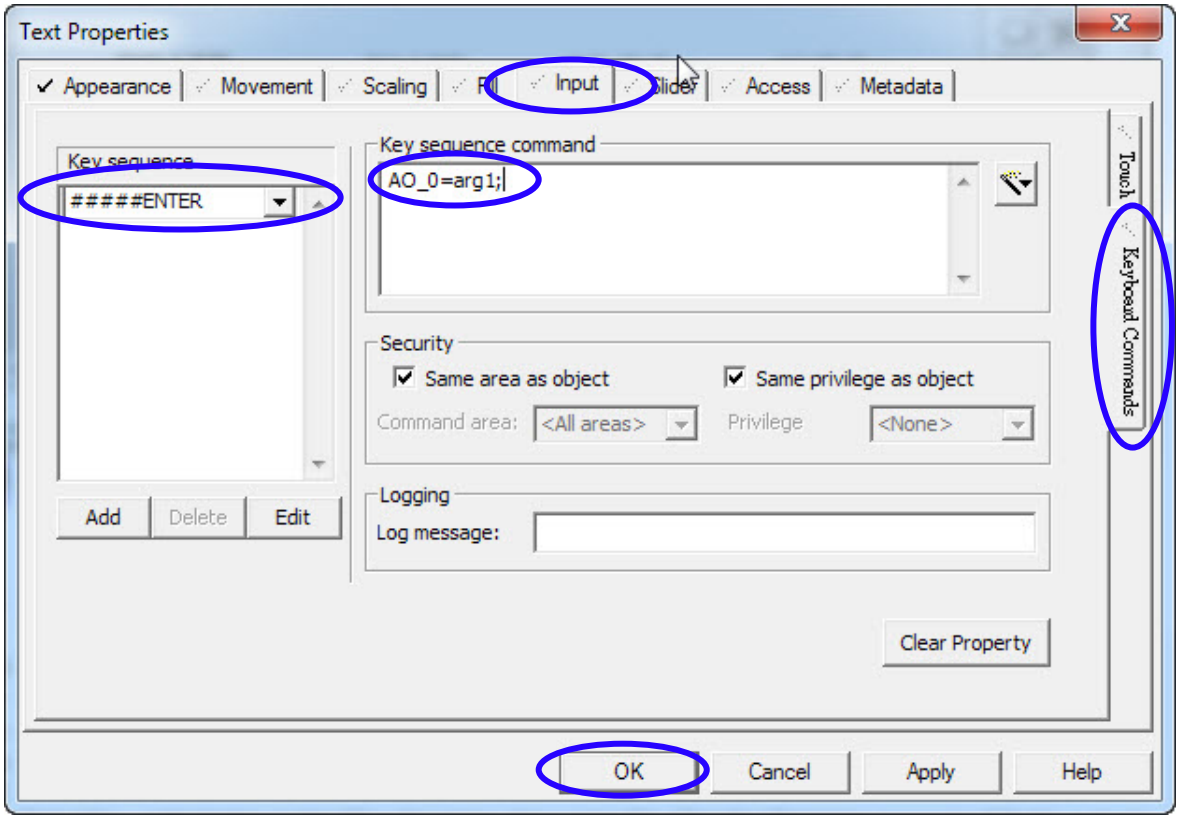
Step 17: Once release the cursor, the “Text Properties” dialog box will be displayed. Click the "Appearance" tab, and click the "Numeric" radio button in the "Type" section, and then enter "AO_0" in the "Numeric expression" field, and set the "Format" to "##.##". Click the "Input" tab and enter "#####ENTER" in the "Key sequence" field box. Enter "AO_0=arg1;" in the "Command" field, and then click the "OK" button to save the changes.





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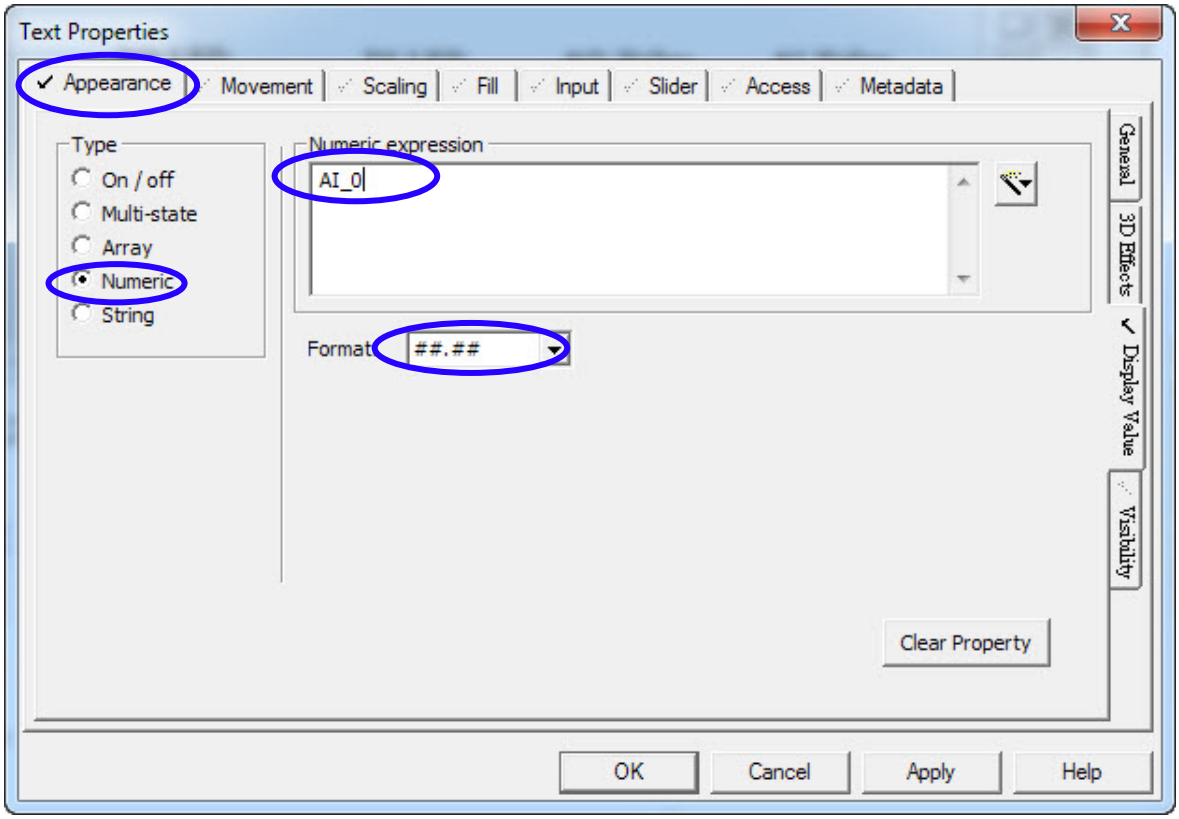
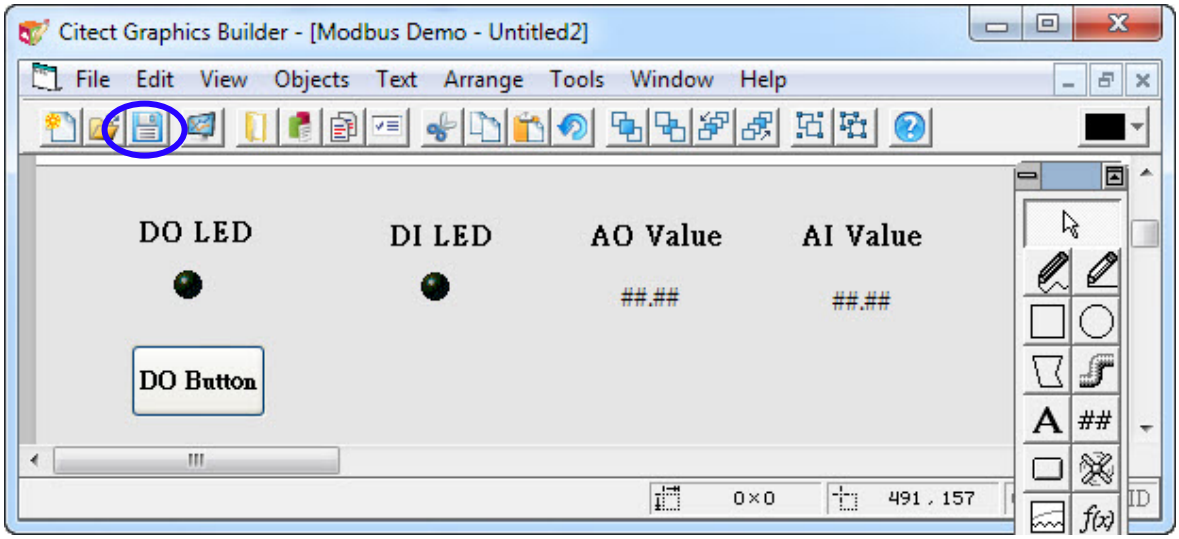
Step 18: Repeat Step 16 to create another new number object and place it below the "AI Value" text object. When the "Text Properties" dialog box is opened for the new Number object, click the "Appearance" tab. Click the "Numeric" radio button in the "Type" section, then enter "AI_0" in the "Numeric expression" field, and set the "Format" to "##.##". In this case, there is no need to set the Input parameters, so click the "OK" button to save the changes.



Step 19: The layout for the finished page is shown below. Click the "Save" button to save the page.



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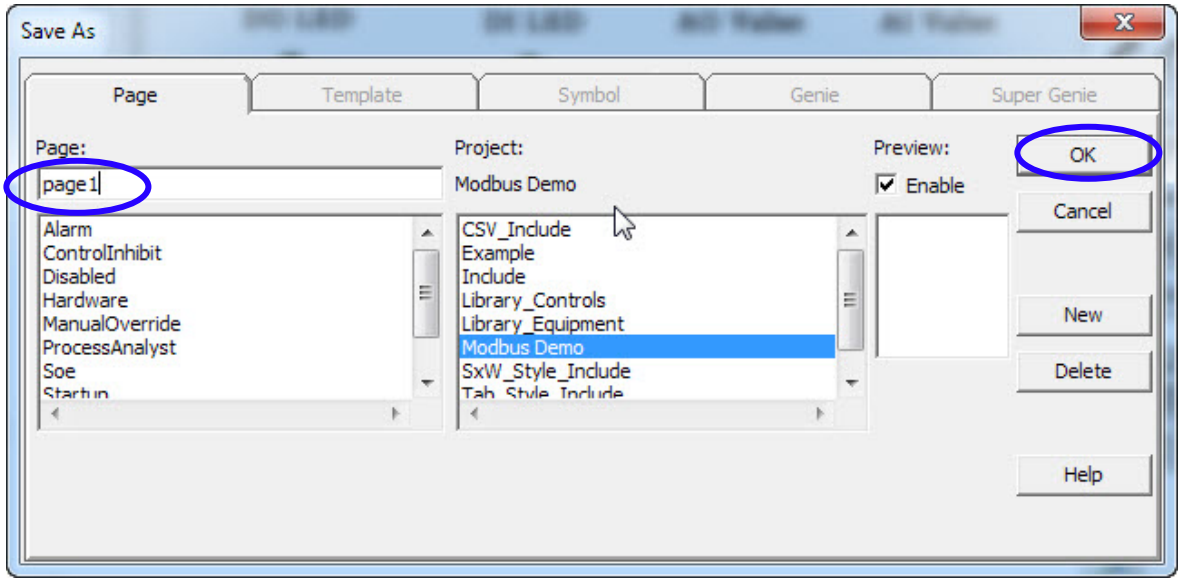
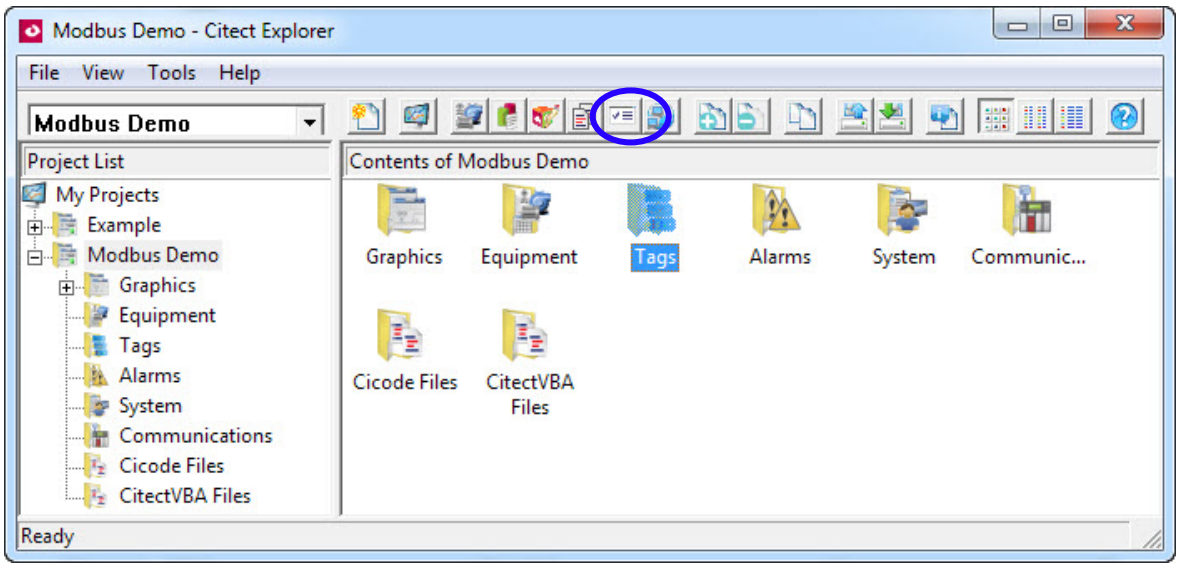
Step 20: In the "Page" field, enter "page1" as the name of the page and then click the “OK” button.



Step 21: Switch the screen to the “Citect Explorer” window, Click the "Computer Setup Wizard" button to open the "Computer Setup Wizard".



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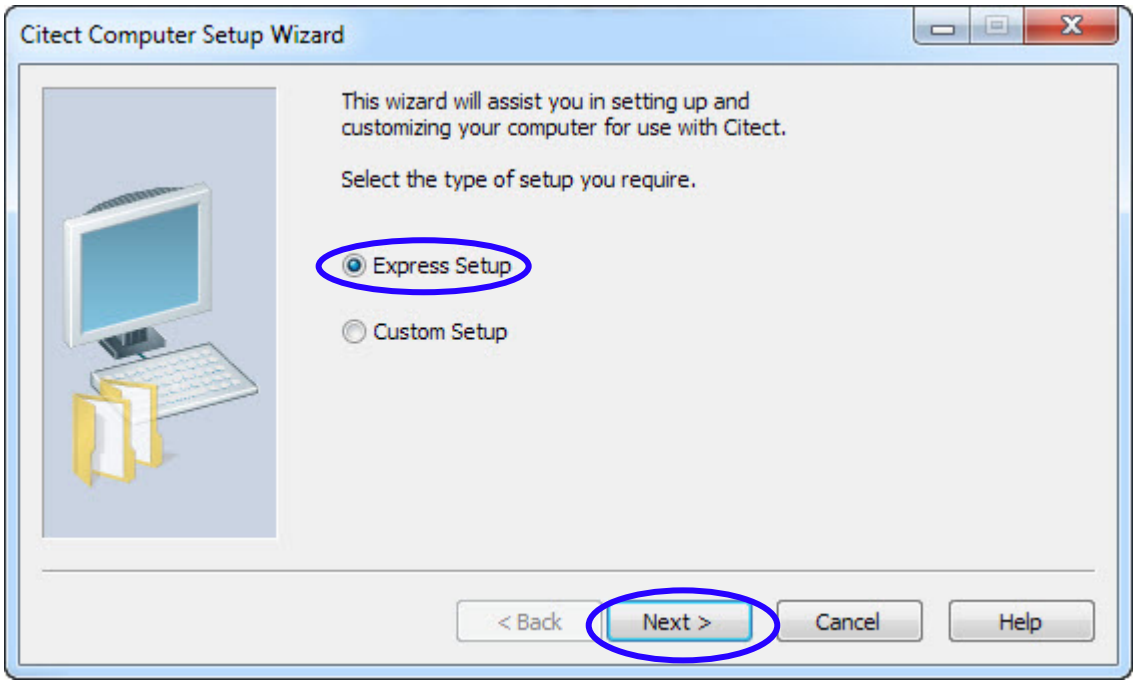
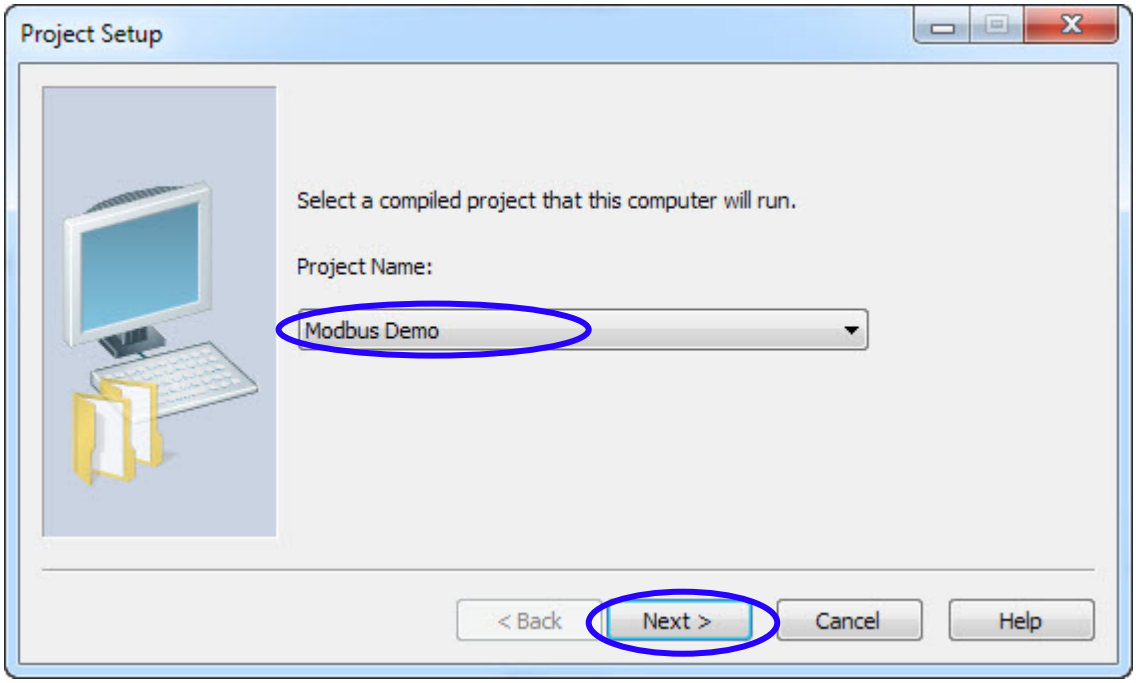
Step 22: Click the "Express Setup" radio button and then click the "Next >" button to continue.


Citect Computer Setup Wizard
This wizard will assist you in setting up and customizing your computer for use with Citect.
Select the type of setup you require.
Express Setup
Custom Setup
< Back
Next >
Cancel
Help

Step 23: Select "Modbus Demo" from the "Project Name" drop-down menu and then click the "Next >" button to continue.



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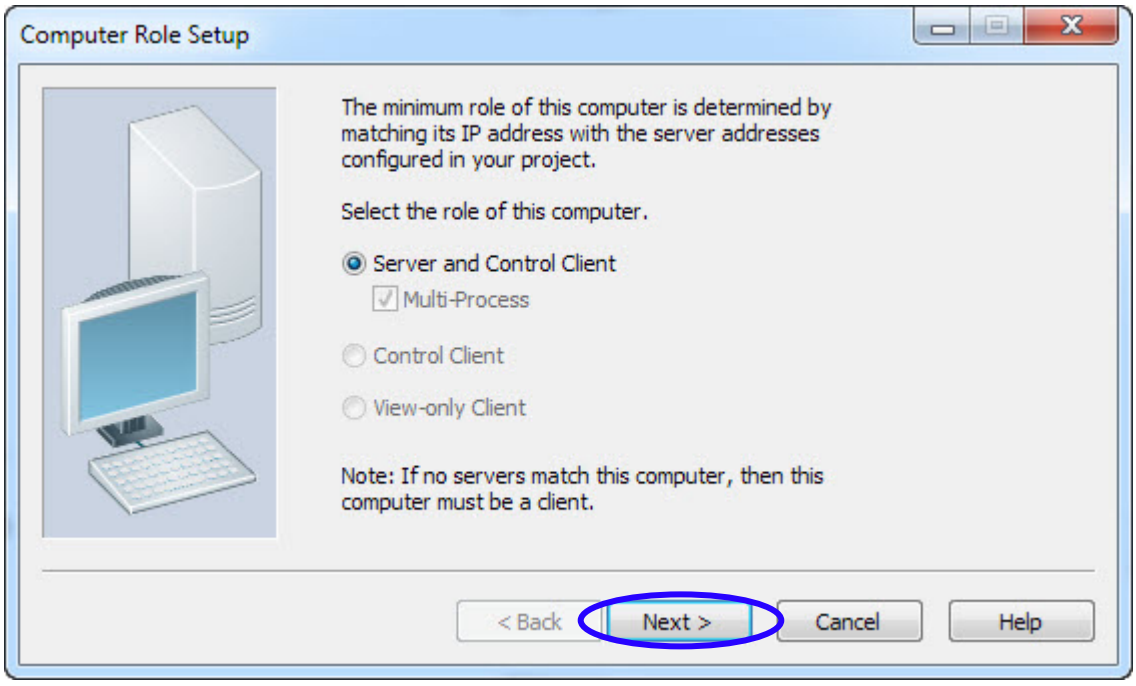
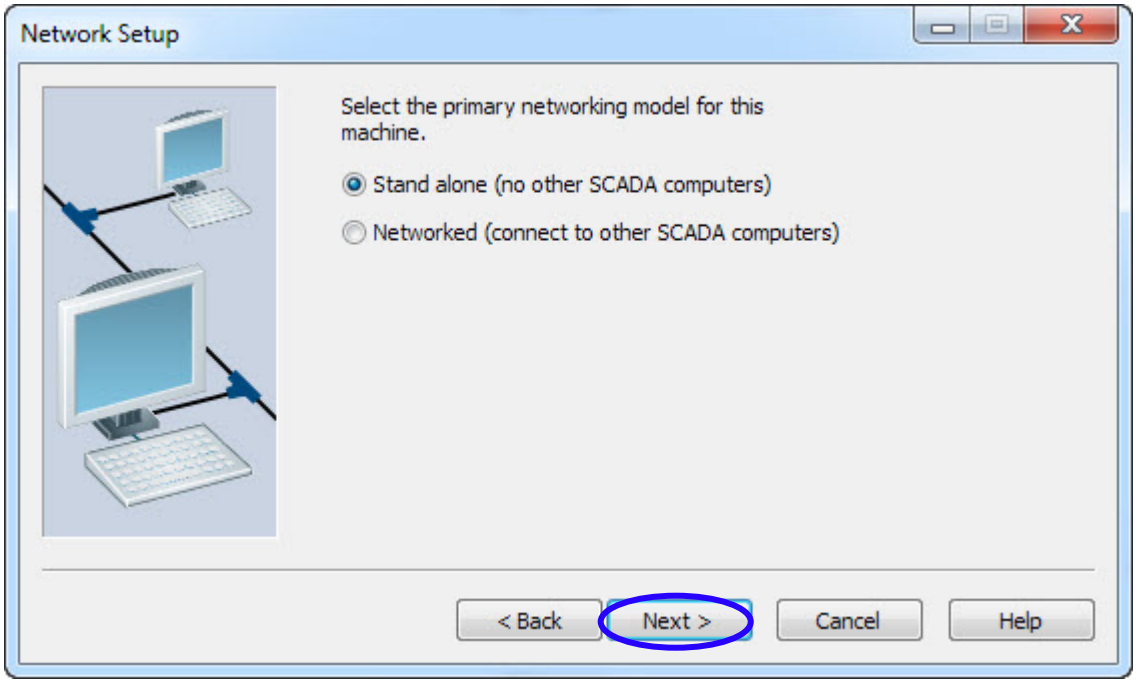
Step 24: Click the "Server and Control Client" radio button, and click the "Next >" button to continue.


Computer Role Setup
The minimum role of this computer is determined by matching its IP address with the server addresses configured in your project.
Select the role of this computer.
Server and Control Client
Multi-Process
Control Client
View-only Client
Note: If no servers match this computer, then this computer must be a client.
< Back
Next >
Cancel
Help

Step 25: Click the “Stand alone (no other SCADA computers)” radio button and click the “Next >” button to continue.


Network Setup
Select the primary networking model for this machine.
Stand alone (no other SCADA computers)
Networked (connect to other SCADA computers)
< Back
Next >
Cancel
Help

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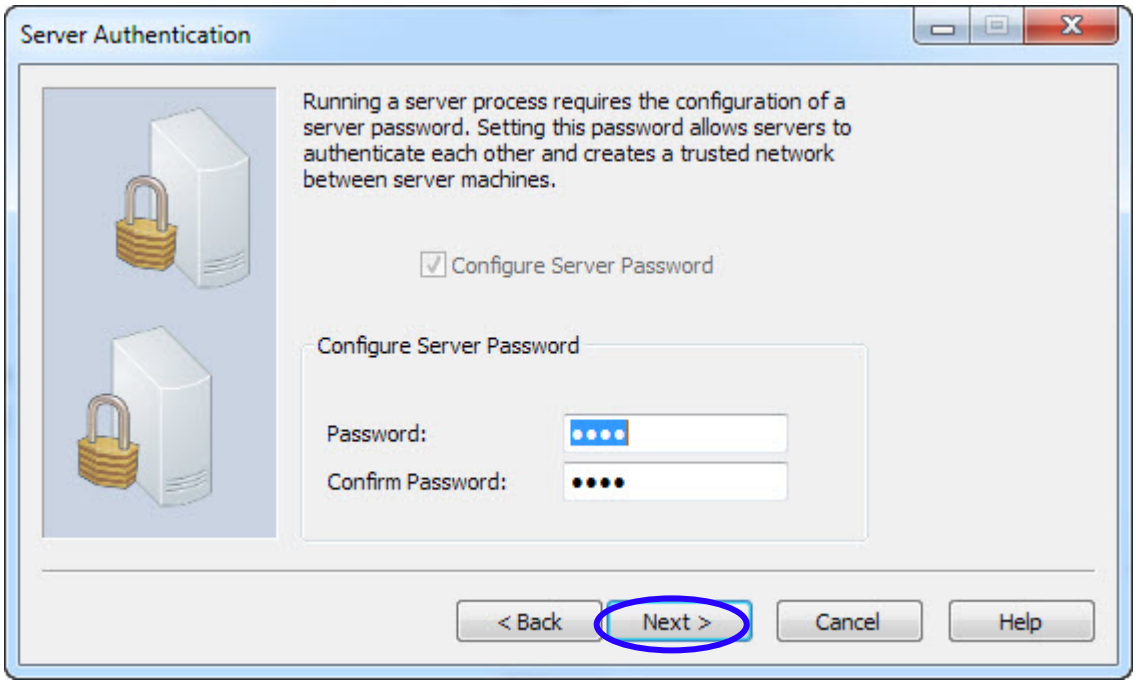
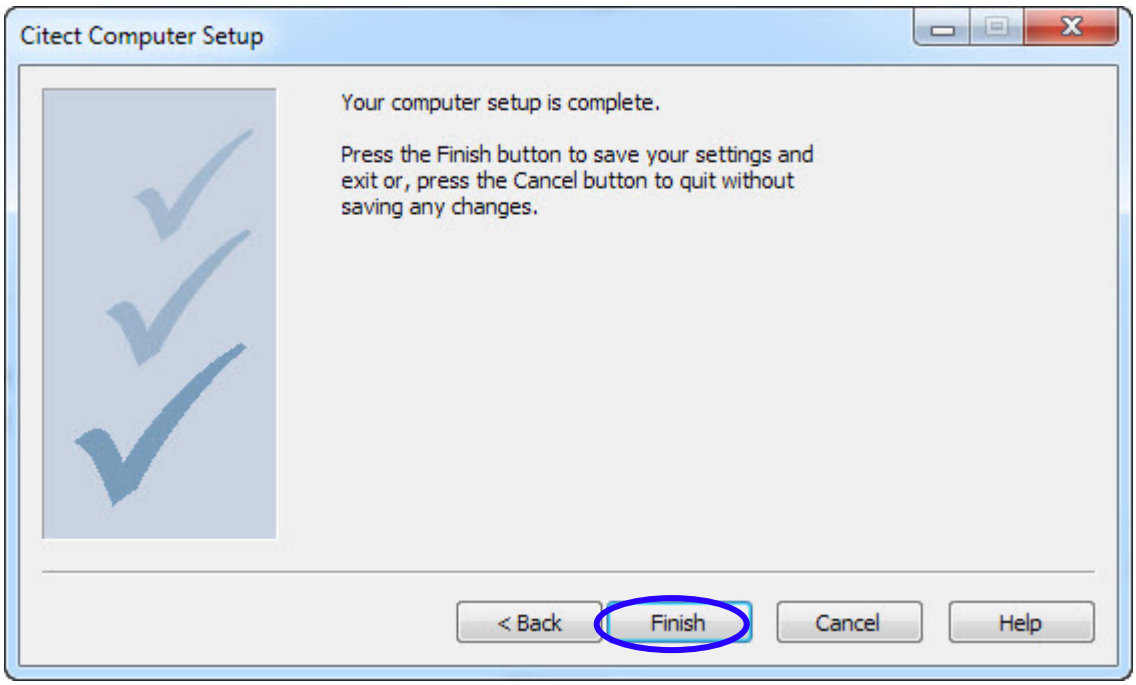
Step 26: Enter the password in the “Password” text field and “Confirm Password” field to set the password for the server, and click the “Next >” button to continue.


Server Authentication
Running a server process requires the configuration of a server password. Setting this password allows servers to authenticate each other and creates a trusted network between server machines.
Configure Server Password
Configure Server Password
Password:
Confirm Password:
< Back
Next >
Cancel
Help

Step 27: Click the "Finish" button to complete the computer setup.


Citect Computer Setup
Your computer setup is complete.
Press the Finish button to save your settings and exit or, press the Cancel button to quit without saving any changes.
< Back
Finish
Cancel
Help

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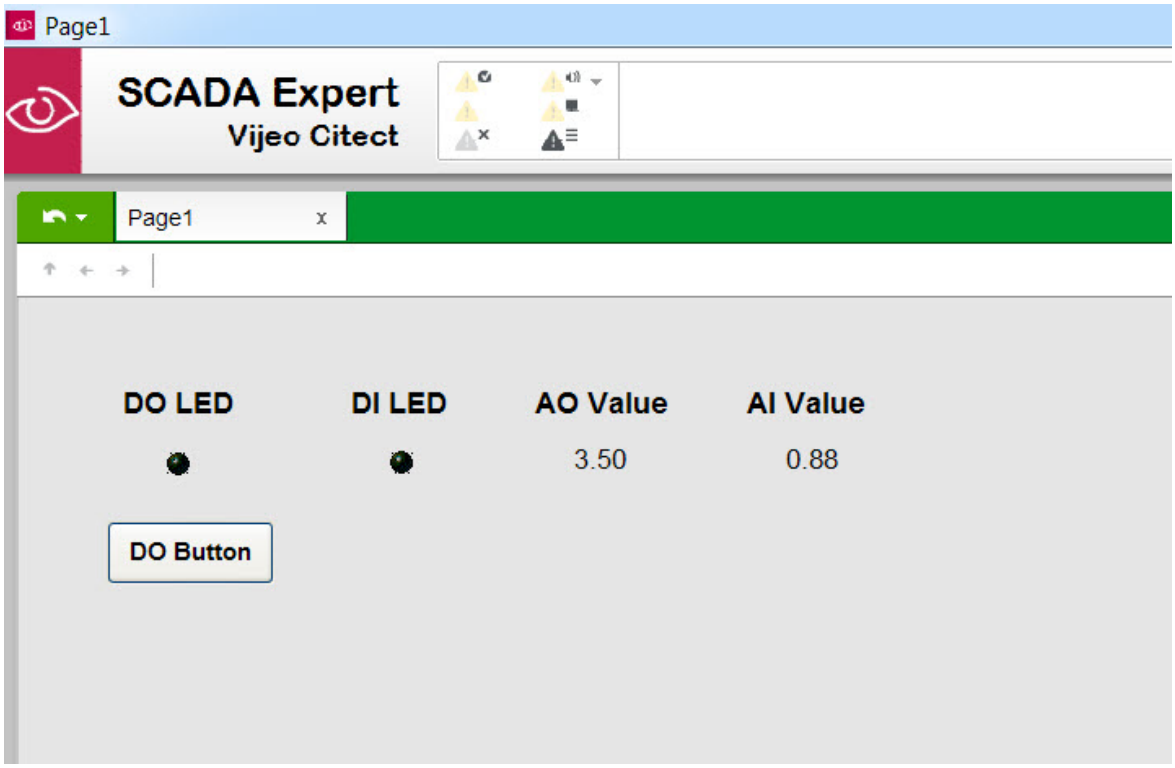
Step 28: Press F5 to execute the project. Verify that clicking the "DO Button" button or clicking the Analog Output "Number object" to enter a value will change the value for the Digital Output and the Analog Output.



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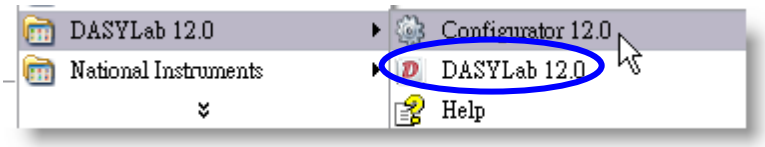
3.2 DASYLab

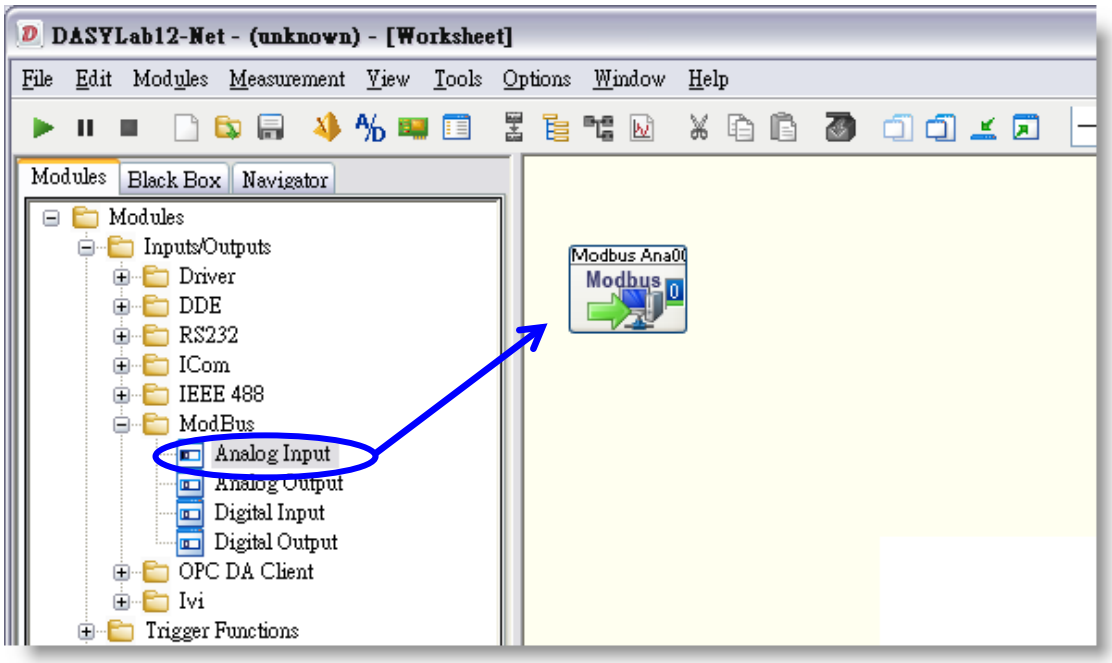
In this section, a detailed description of the procedure for connecting the DASYLab solution to the I-8000-MTCP/ IP-8000-MTCP controller via the Modbus/TCP protocol is presented. In this example, DASYLab version 12 is used. This solution can also be used to request data from external devices such as the ET-7000, I-7188-MTCP, or WISE-7000 using the Modbus protocol.
Before using DASYLab, the controller should be correctly configured using the Modbus Utility. The Net ID is set using the DIP switch located on the right-hand side of the controller (see Section 2.4 Net ID (Station number) Setting for more information).

3.2.1. Adding an Analog Input Channel

Step 1: Open the DASYLab software.



Step 2: In the "Modules" folder, expand the "Inputs/Outputs" folder and then expand the "ModBus" folder. Drag a Modbus Analog Input module to the worksheet.



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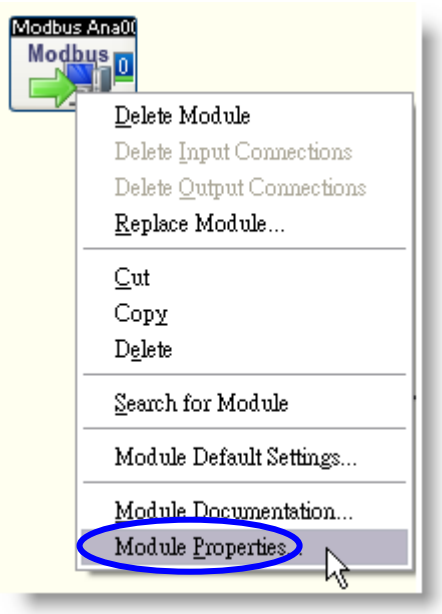
Step 3: Right-click the module icon and click the “Module Properties” option.



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Step 4: Configure the module properties in the Modbus Analog Input dialog box.

A. In the "Interfaces" section, set the Interface to TCP/IP and enter the IP address.

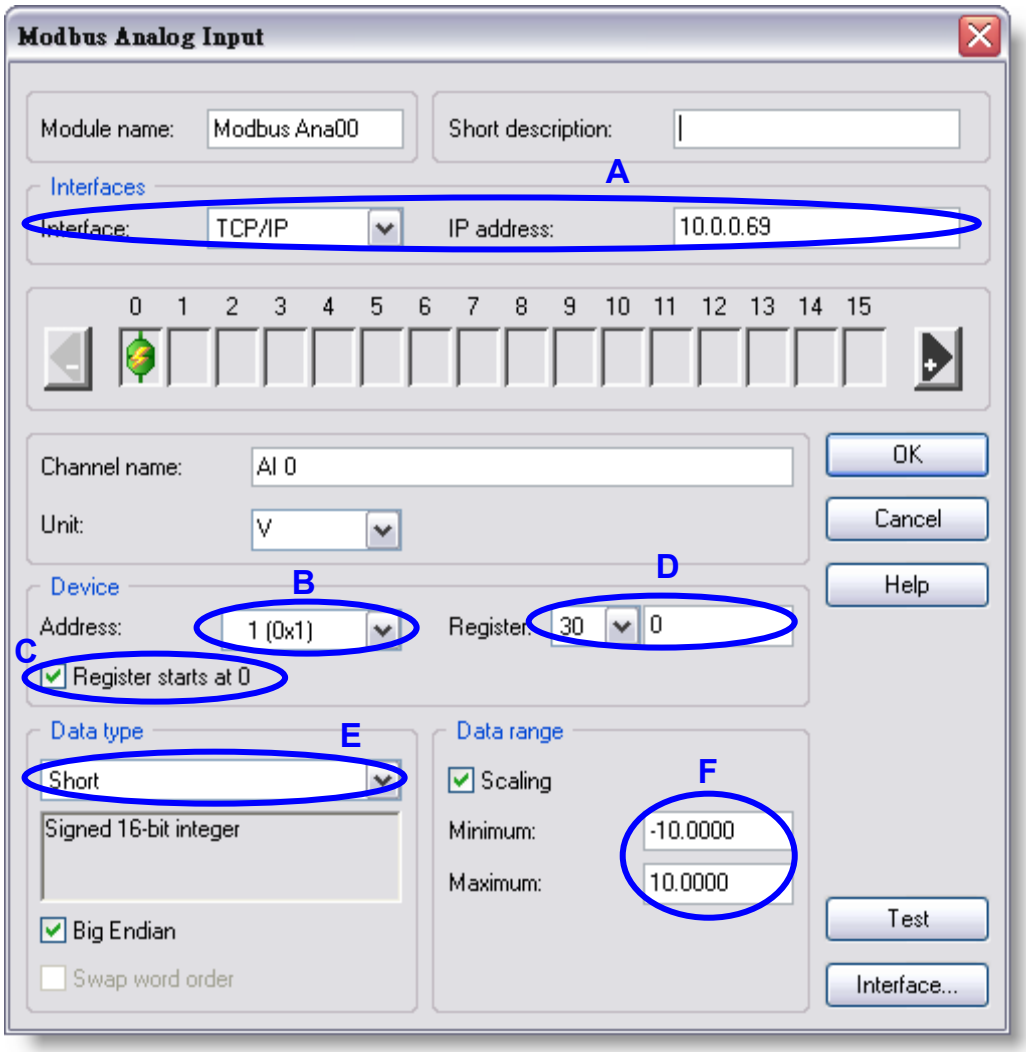
B. In the "Device" section, set the Address, which is the Net ID of the controller.

C. Check the "Register starts at 0: checkbox.

D. Enter the register address, which can be found from the address mapping table in the Modbus Utility. Select 30 for Analog Input channels. In this demo, the register is set to 30000.

E. Set the Data Type, which is a signed 16-bit integer in this demo.

F. In the "Data range" section, enable Scaling by checking the "Scaling" checkbox, and set the minimum and maximum values, which are -10 to 10V in this demo.



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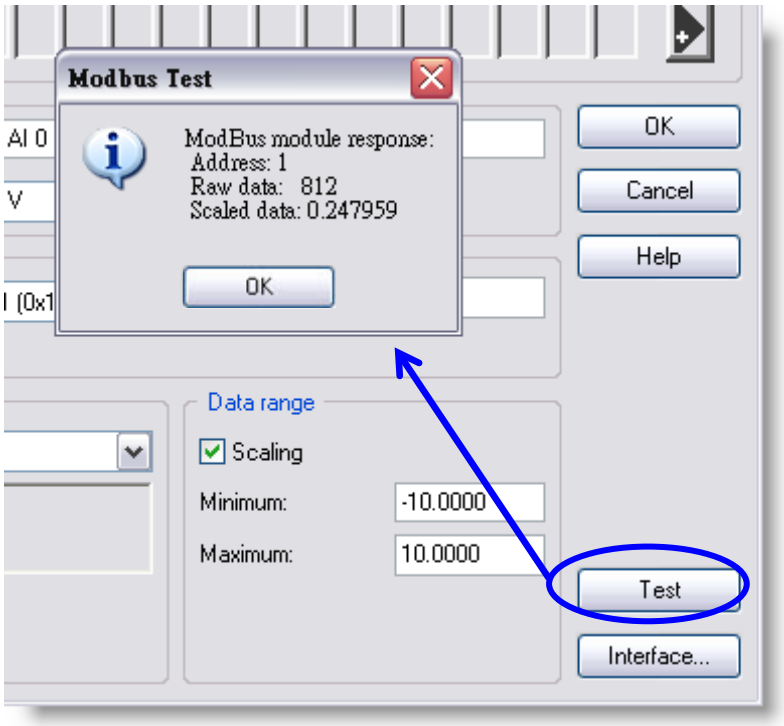
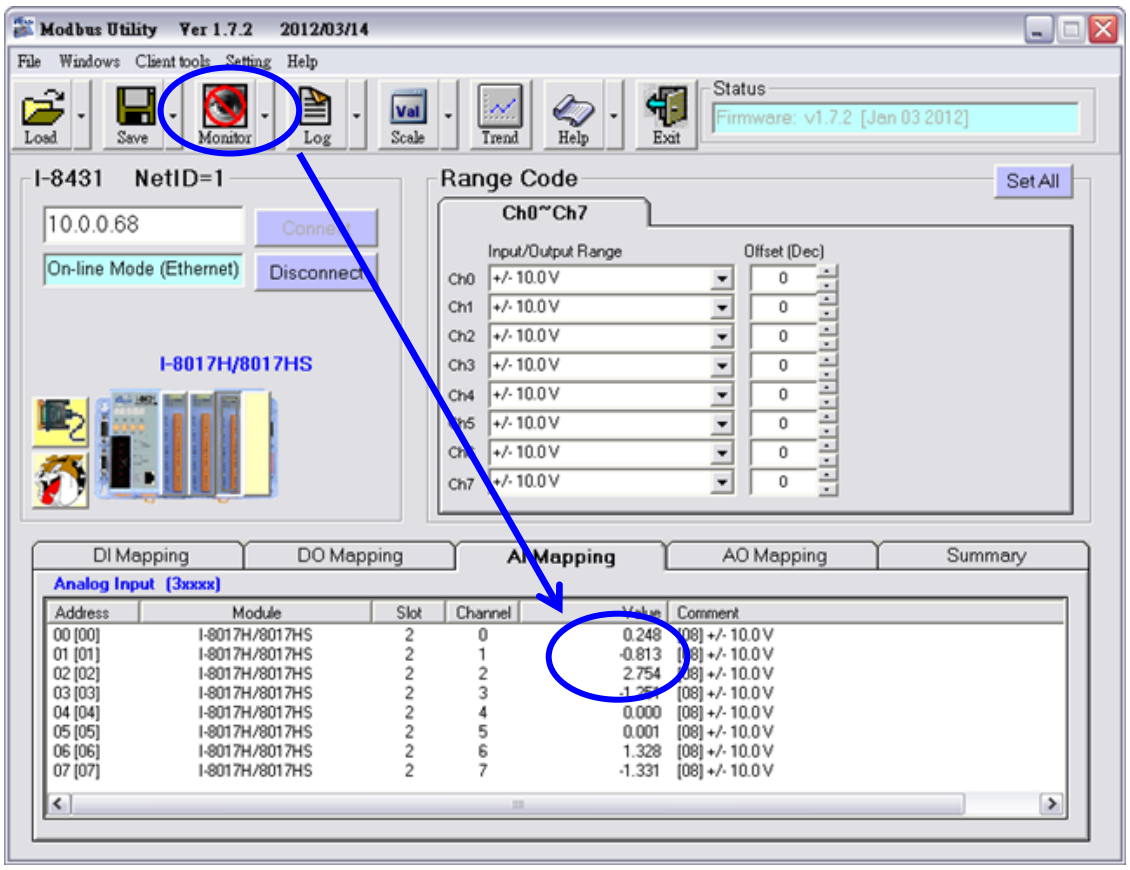
Step 5: Click the "Test" button to verify the settings and then click the "OK" button to save the configuration. The data can also be checked on the "AI Mapping" using the Modbus Utility.





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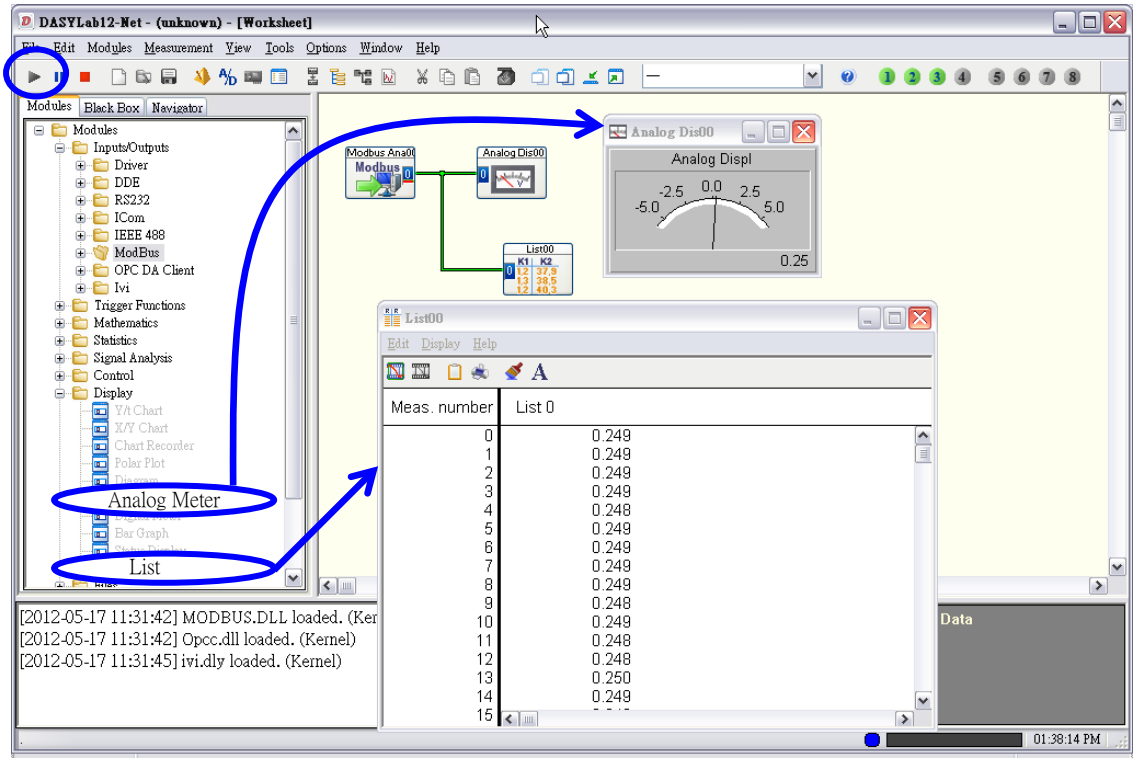
Step 6: In the “Modules” folder, expand the “Display” folder. Drag an Analog Meter or a List to the worksheet. Click the “run” triangle button to connect to the module and acquire data.



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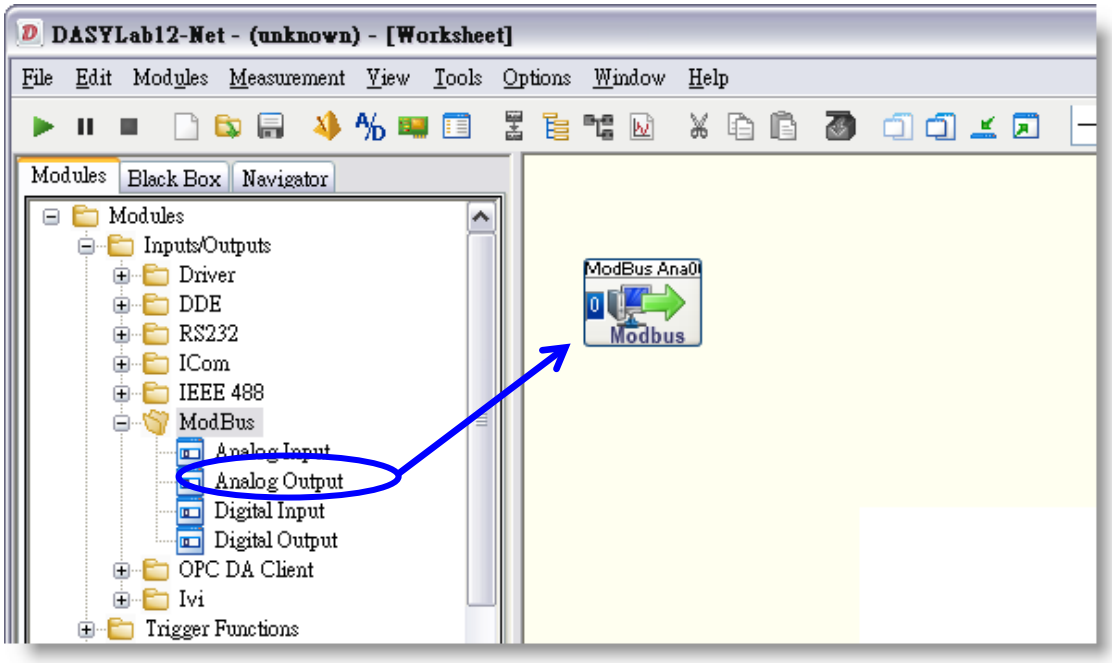
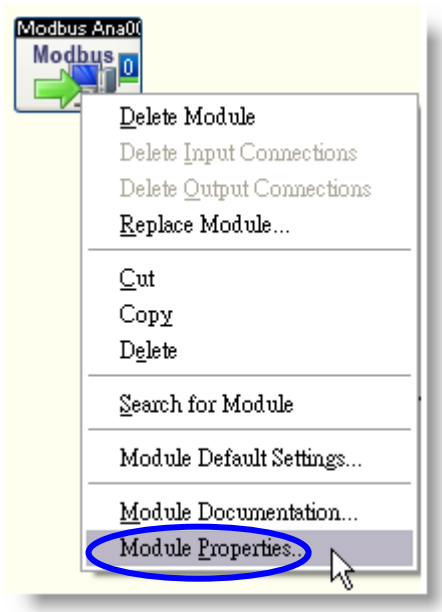
3.2.2. Adding an Analog Output Channel

Step 1: In the "Modules" folder, expand the "Inputs/Outputs" folder and then expand the "ModBus" folder. Drag a Modbus Analog Output module to the worksheet.



Step 2: Right-click the module icon and click the "Module Properties" option.



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Step 3: Configure the module properties in the Modbus Analog Output dialog box.

A. In the "Interfaces" section, set the Interface to TCP/IP and enter the IP address.

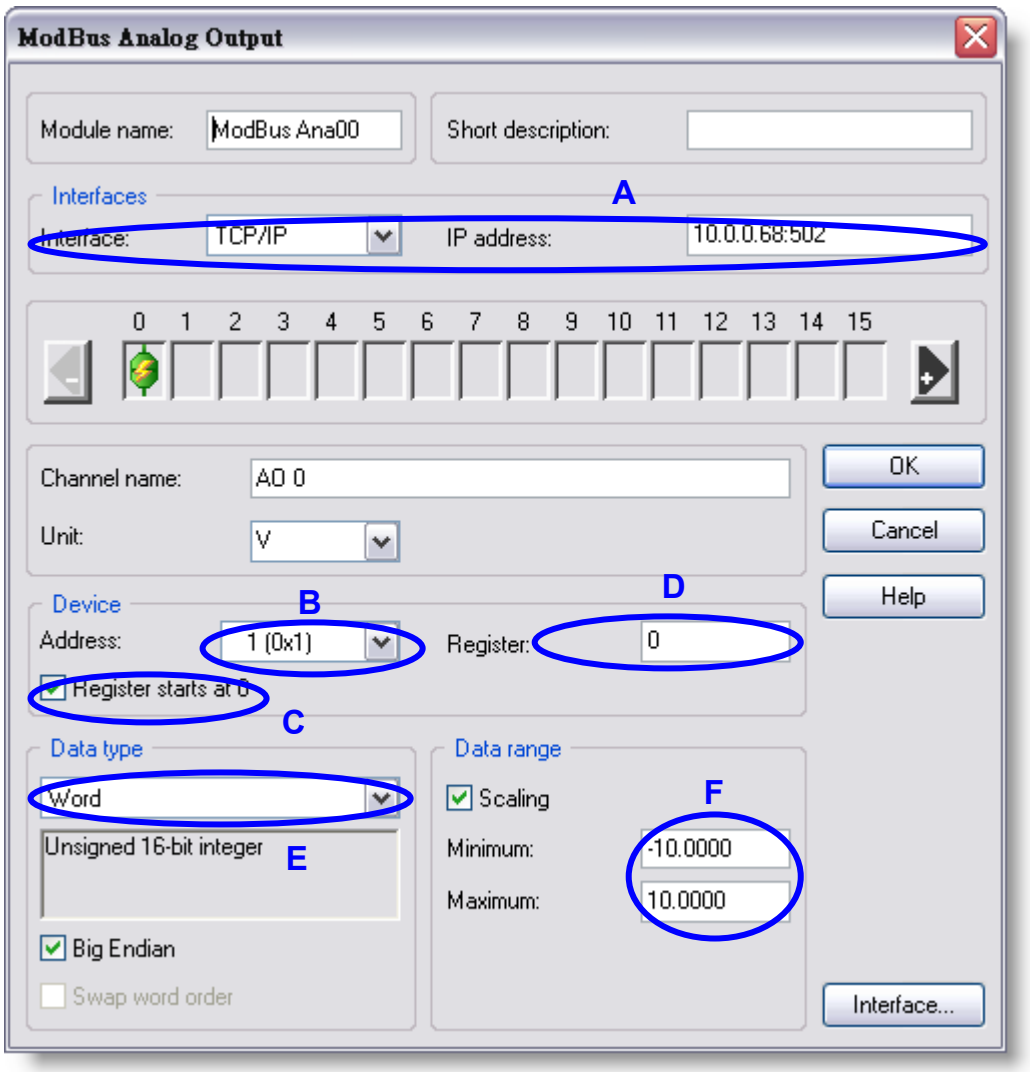
B. In the "Device" section, set the Address, which is the Net ID of the controller.

C. Check the "Register starts at 0: checkbox.

D. Enter the register address, which can be found from the address mapping table in the Modbus Utility.

E. Set the Data Type, which is a Word unsigned 16-bit integer in this demo.

F. In the "Data range" section, enable Scaling by checking the "Scaling" checkbox, and set the minimum and maximum values, which are -10 to 10V in this demo.



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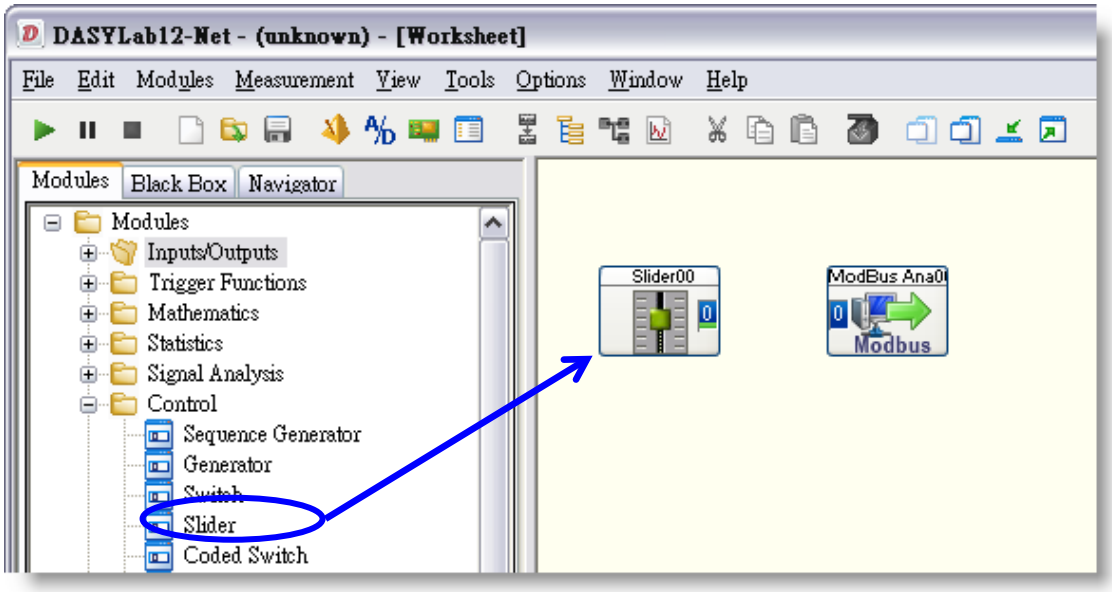
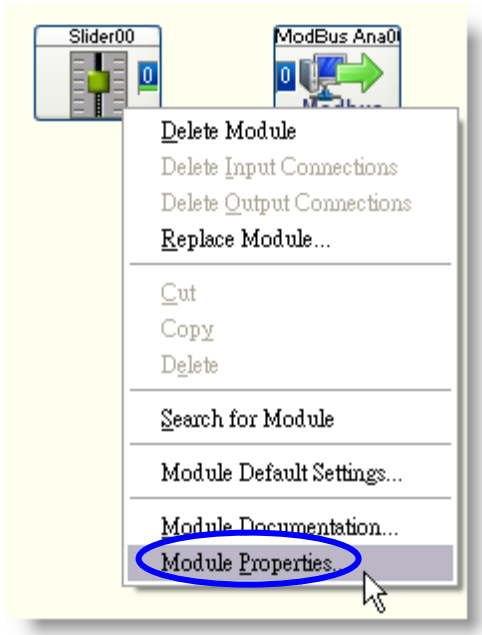
Step 4: In the "Modules" folder, expand the "Control" folder and then drag a Slider Control to the worksheet.



Step 5: Right-click the Slider Control icon and click the "Module Properties" option.



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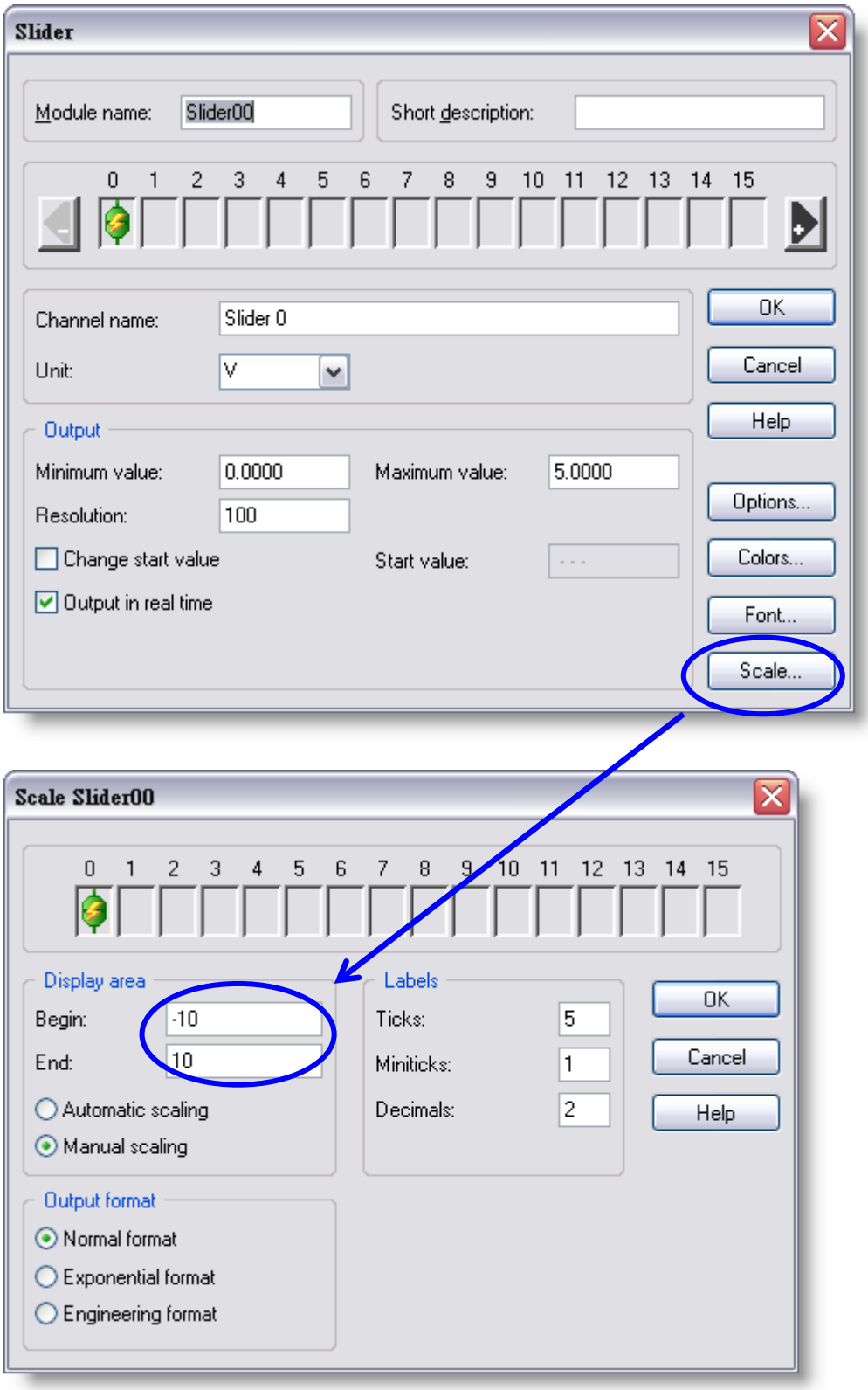
Step 6: Click the "Scale" button and set the Begin and End values in the "Display area" section. In this demo, -10 to +10 are used. Click the "OK" button to continue.



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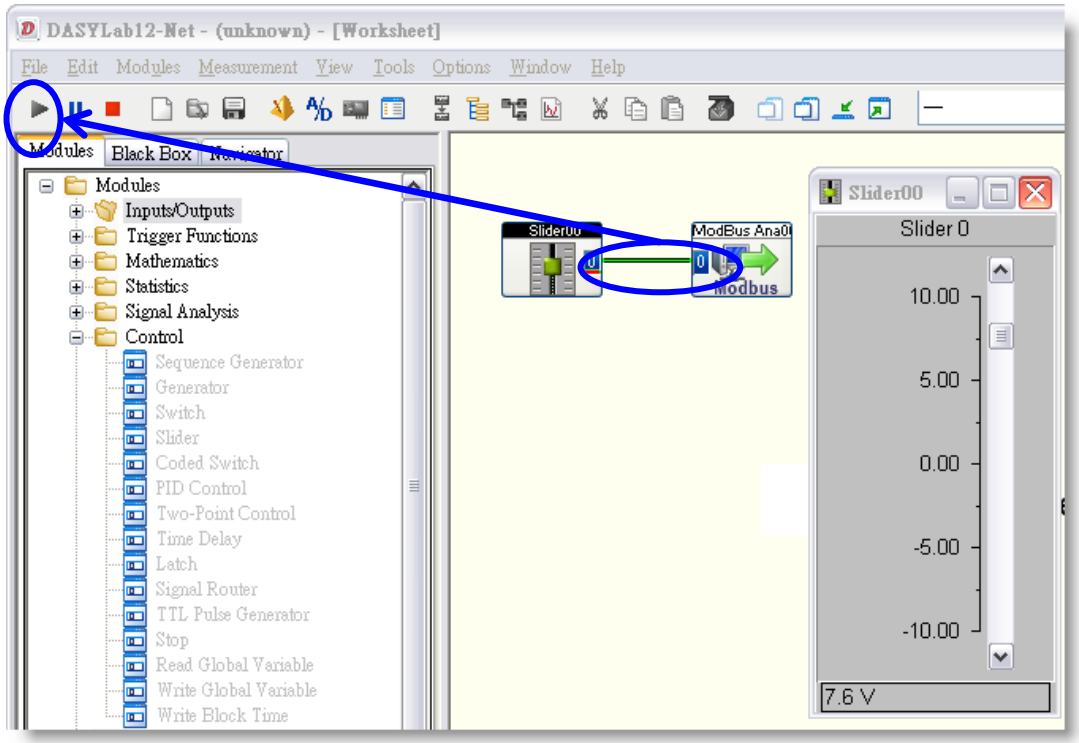
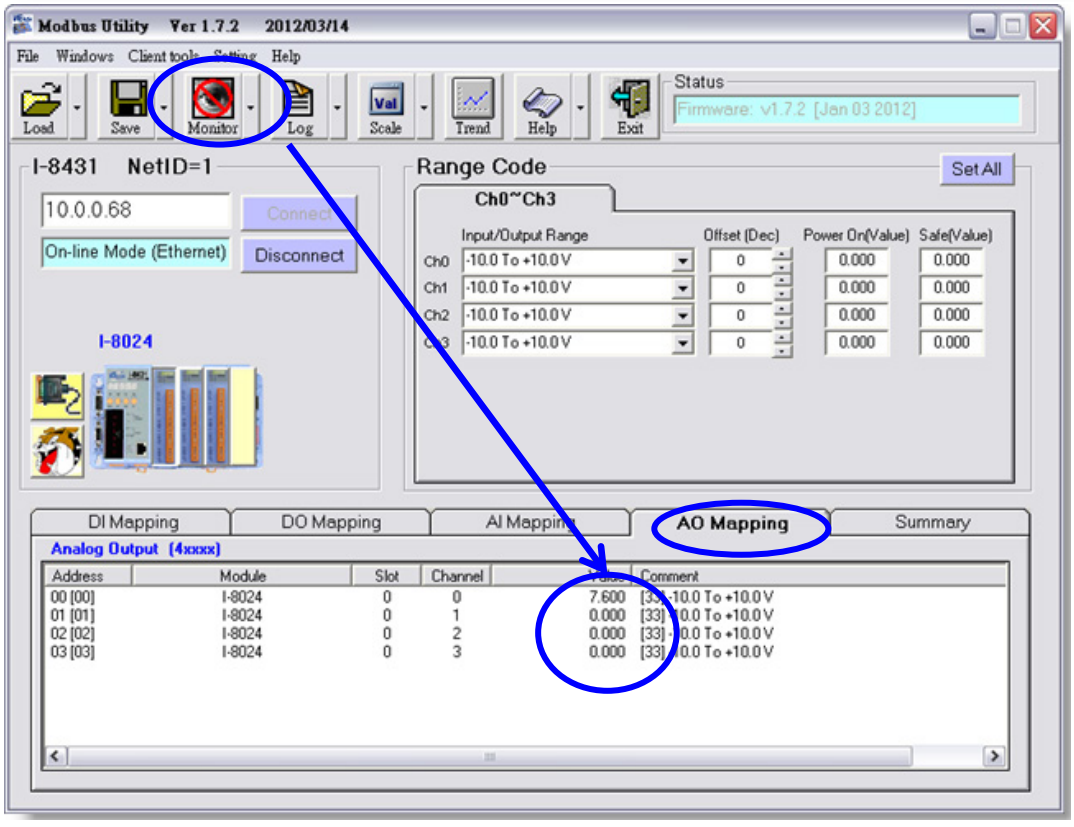
Step 7: Drag a line from the “Slider00” icon to the “ModBus Ana00” icon to establish a connection between the Slider Control and the Analog Output module. Click the “run” triangle button to start exporting value by dragging the Slider Control. The value can also be using the Modbus Utility.





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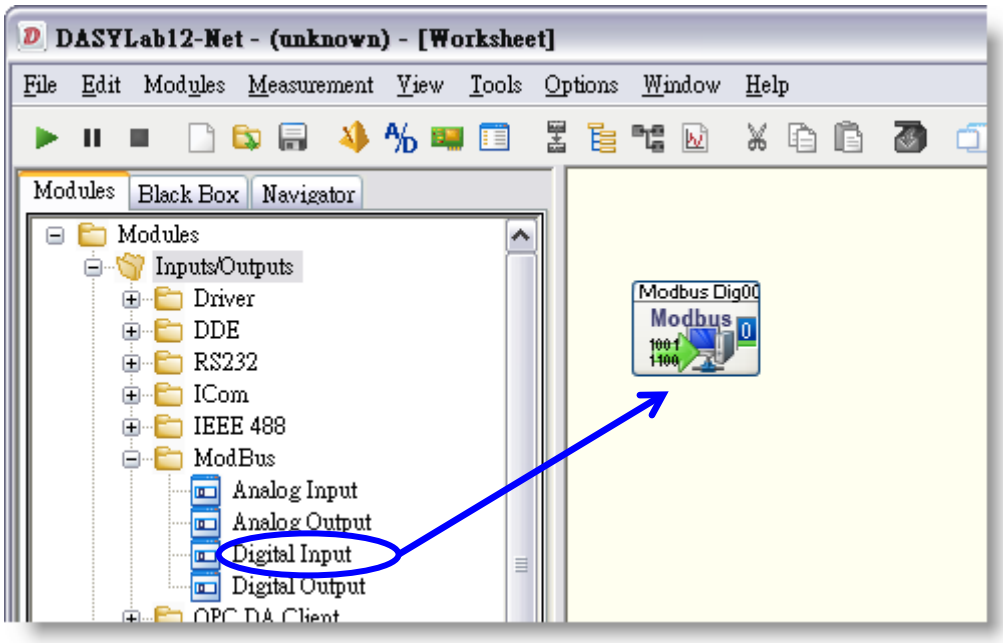
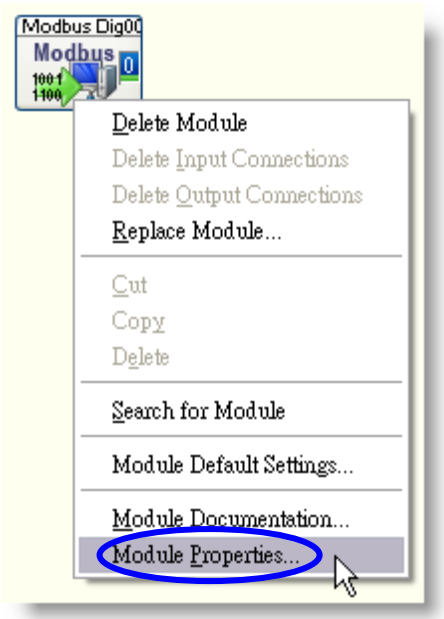
3.2.3. Adding a Digital Input Channel

Step 1: In the "Modules" folder, expand the "Inputs/Outputs" folder and then expand the "ModBus" folder. Drag a Modbus Digital Input module to the worksheet.



Step 2: Right-click the module icon and click the "Module Properties" option.



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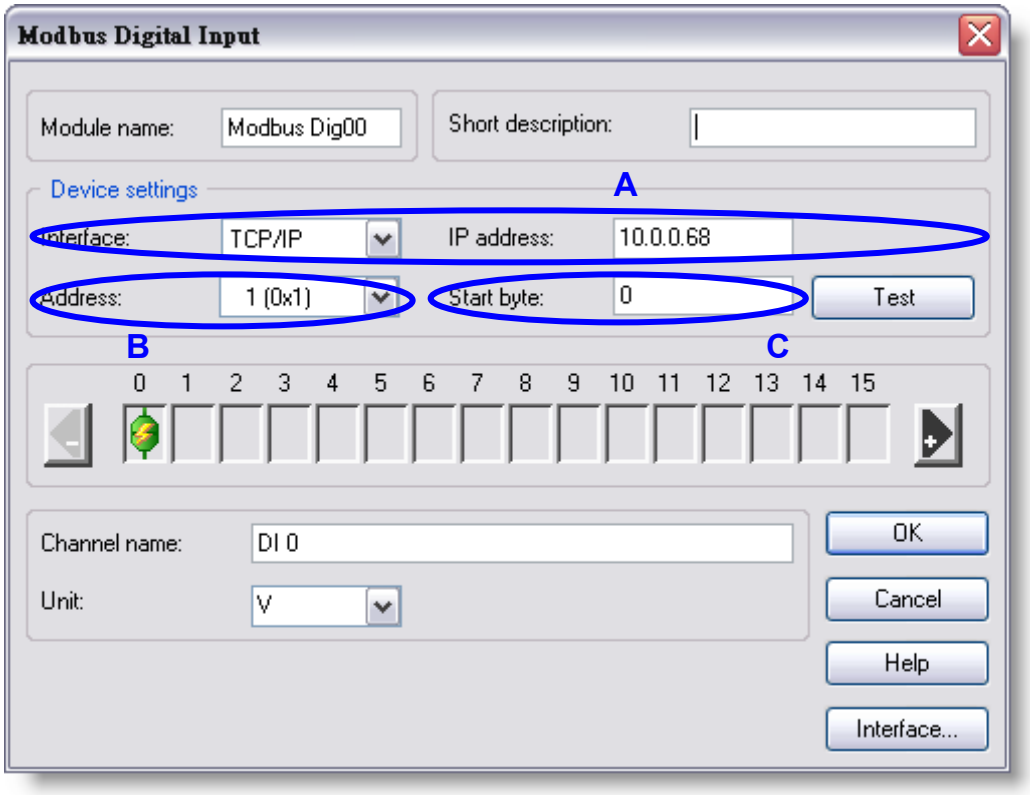
Step 3: Configure the module properties in the Modbus Digital Input dialog box.

A. In the "Device settings" section, set the Interface to TCP/IP and enter the IP address.

B. In the "Device settings" section, set the Address, which is the Net ID of the controller.

C. Enter the Start byte, which can be found from the address mapping in the Modbus Utility.



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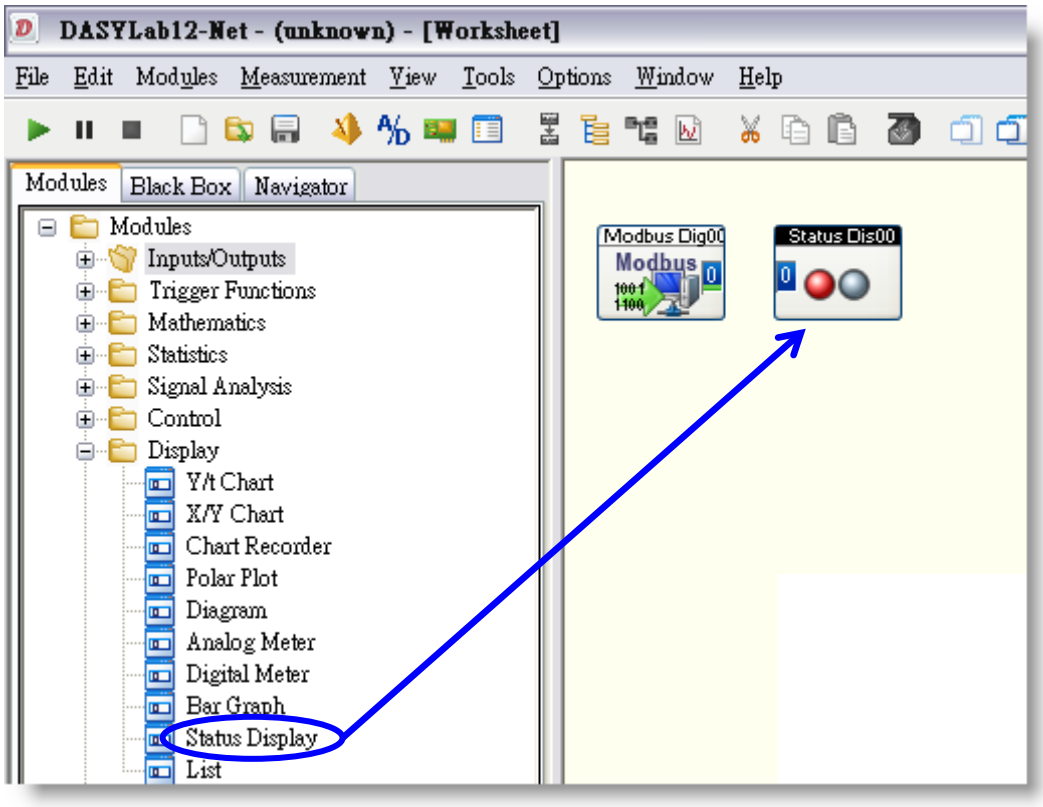
Step 4: In the "Modules" folder, expand the "Display" folder and then drag a Status Display object to the worksheet.



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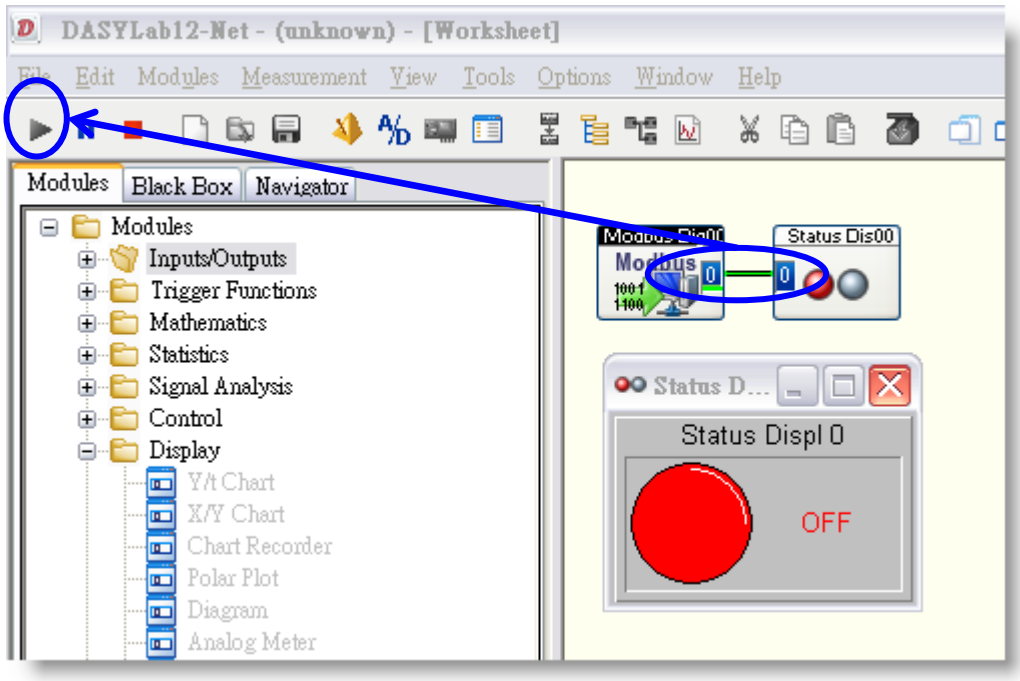
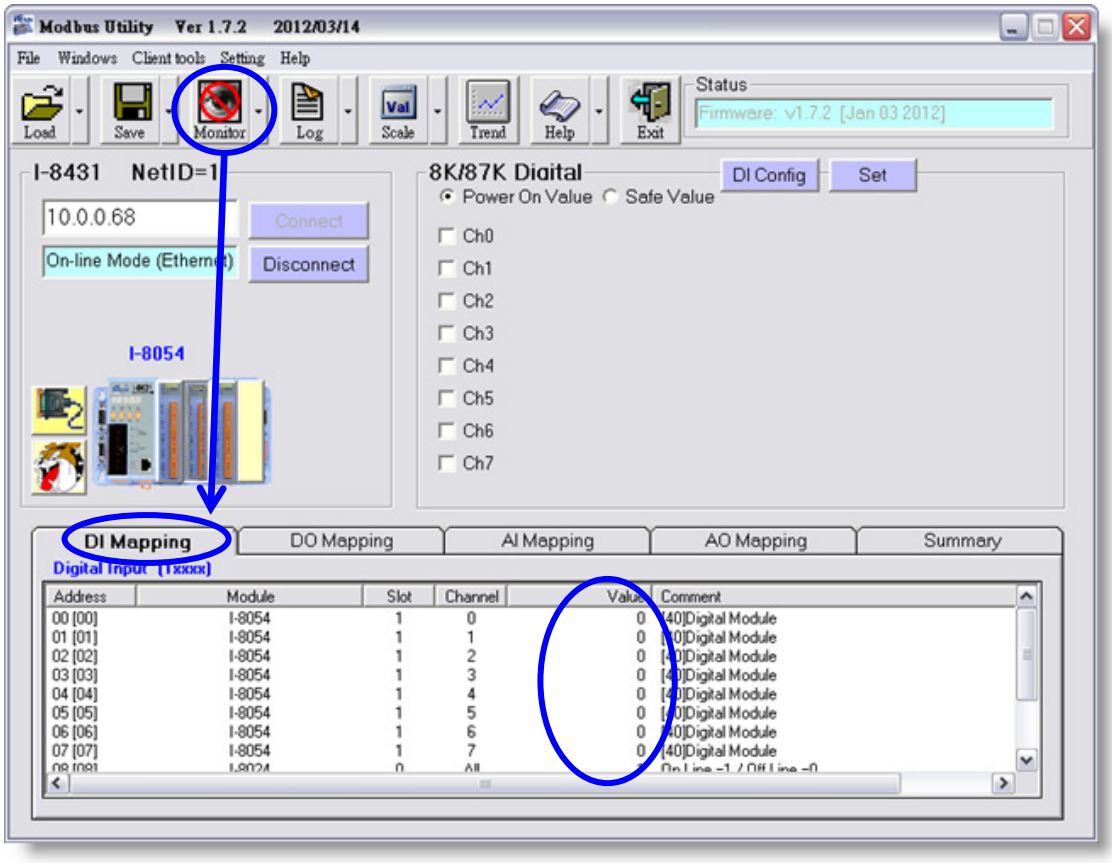
Step 5: Drag a line from the “Status Dis00” icon to the ”Modbus Dig00” icon to establish a connection between the Status Display object and the Digital Input module. Click the “run” triangle button to start acquiring data. The data can also be checked on the “DI Mapping” using the Modbus Utility.





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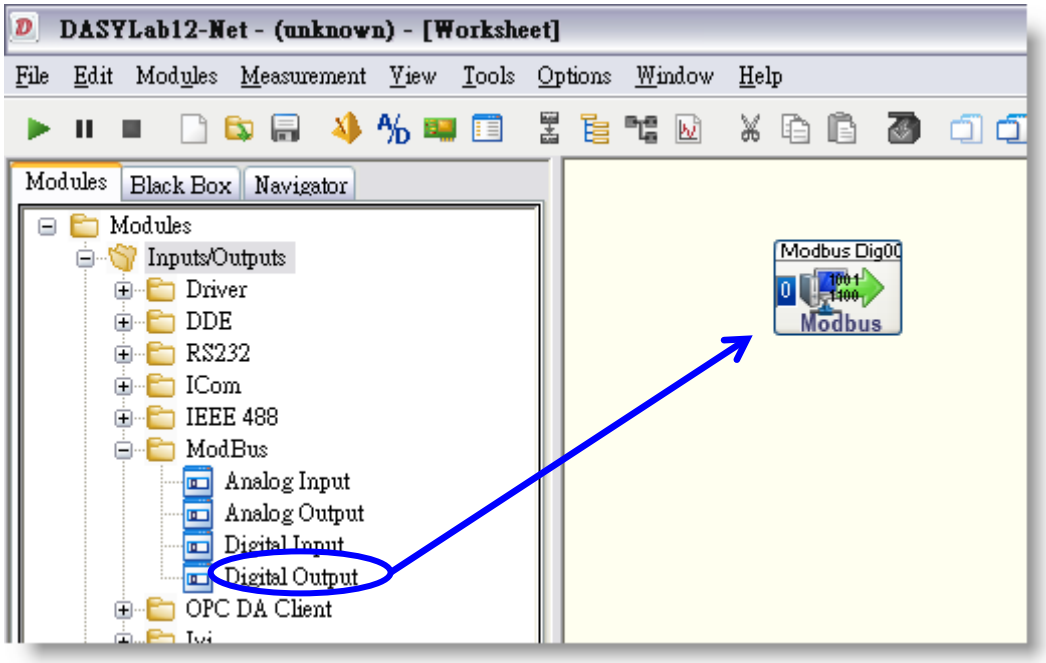
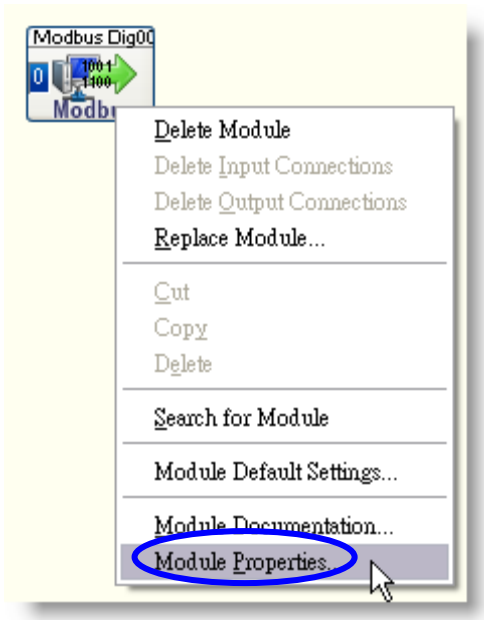
3.2.4. Adding a Digital Output Channel

Step 1: In the "Modules" folder, expand the "Inputs/Outputs" folder and then expand the "ModBus" folder. Drag a Modbus Digital Output module to the worksheet.



Step 2: Right-click the module icon and click the "Module Properties" option.



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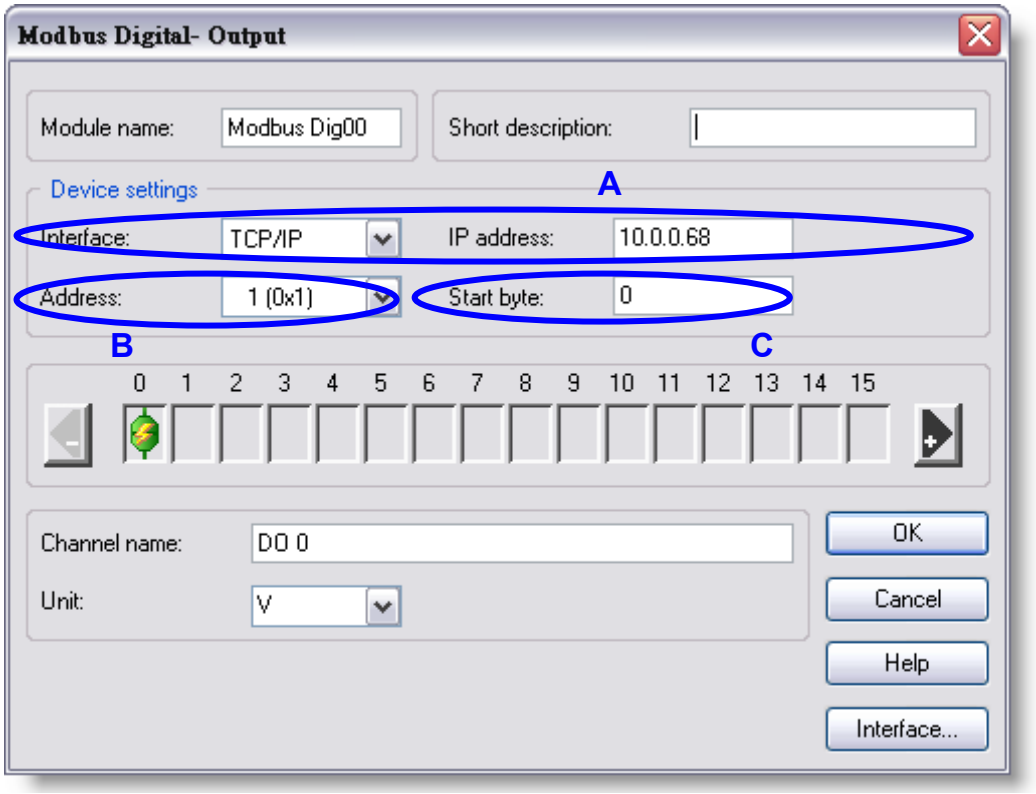
Step 3: Configure the module properties in the Modbus Digital- Output dialog box.

A. In the "Device settings" section, set the Interface to TCP/IP and enter the IP address.

B. In the "Device settings" section, set the Address, which is the Net ID of the controller.

C. Enter the Start byte, which can be found from the address mapping in the Modbus Utility.



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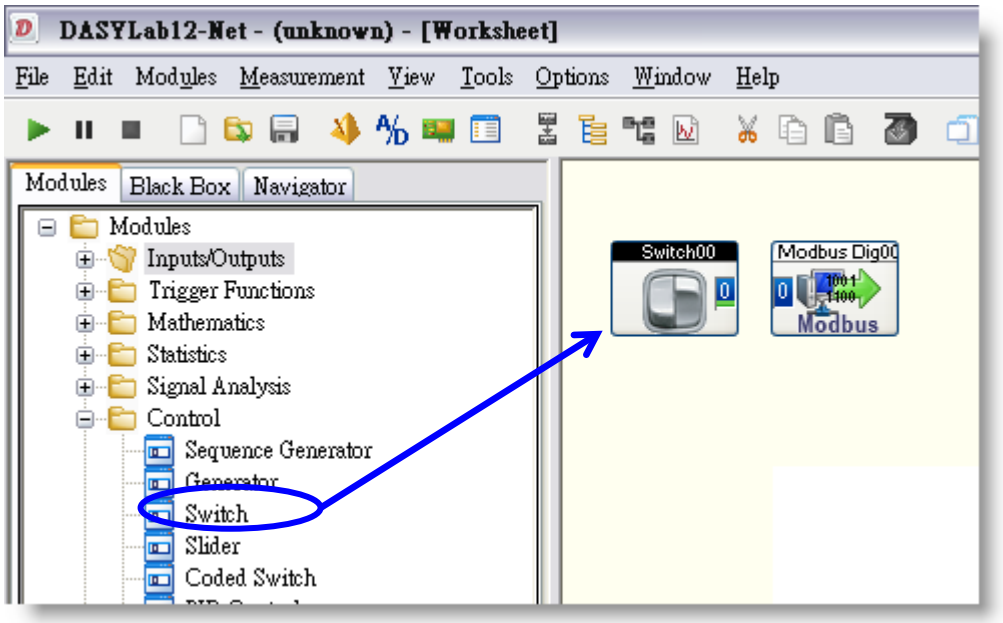
Step 4: In the “Modules” folder, expand the “Control” folder and then drag a Switch Control to the worksheet.



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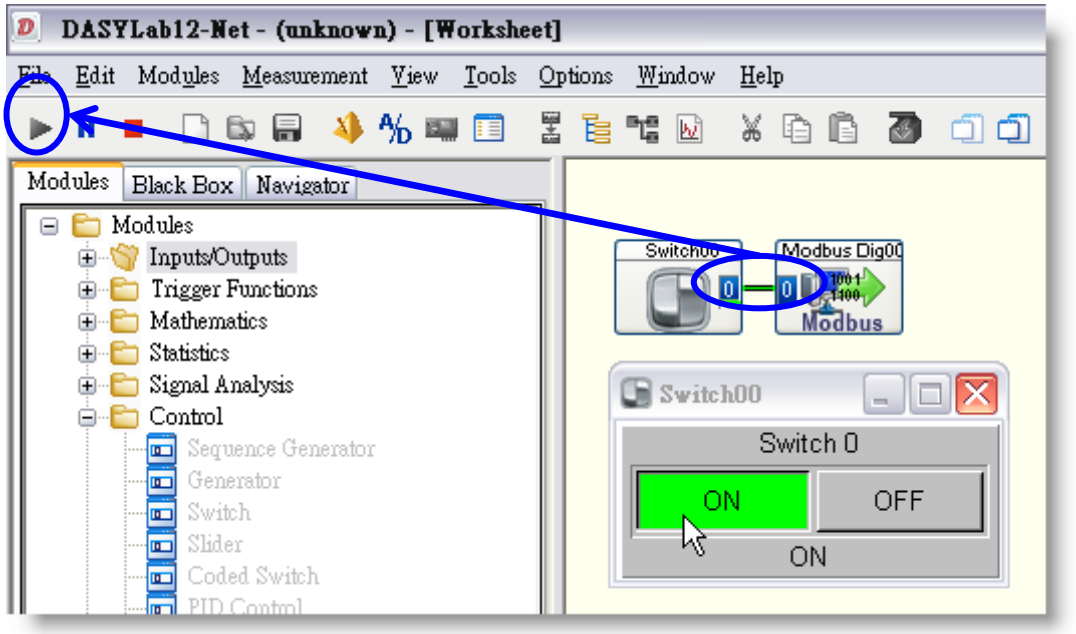
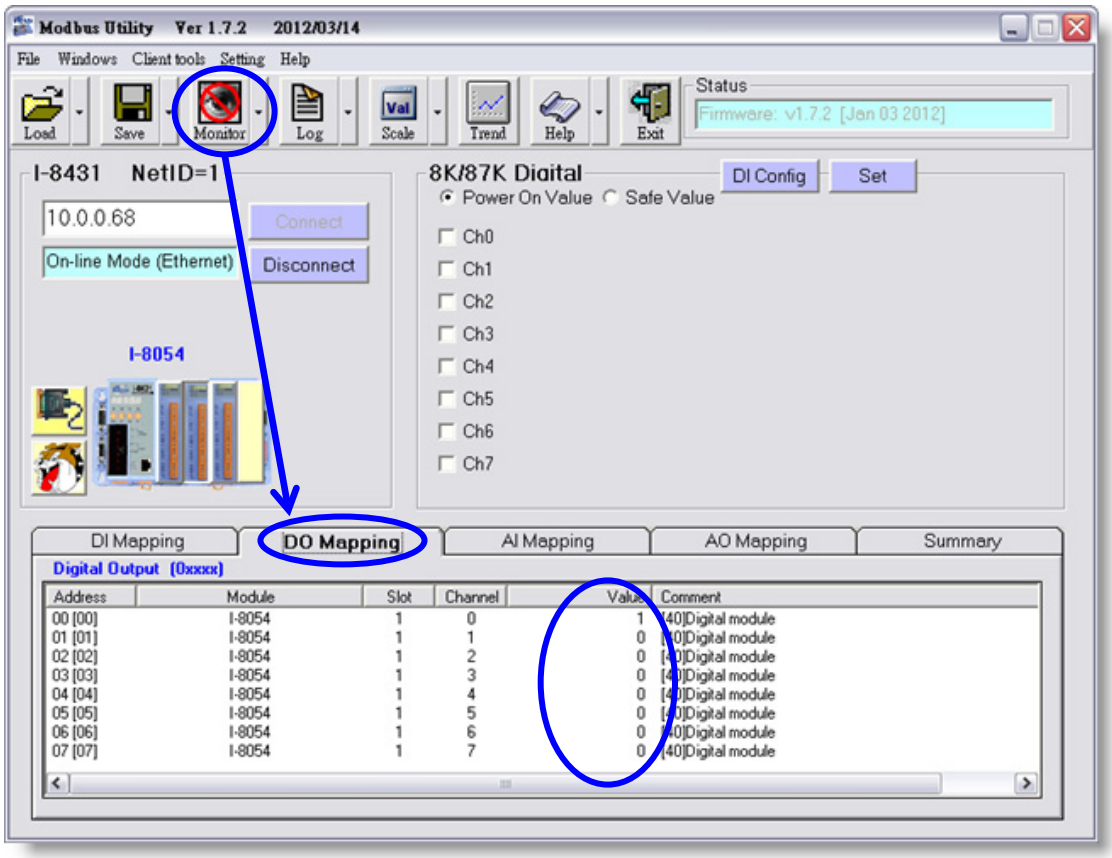
Step 5: Drag a line from the “Switch00” icon to the “Modbus Dig00” icon to establish a connection between the Switch Control and the Digital Output module. Click the “run” triangle button to exporting value by clicking the Switch00. The value can also be set on the “DO Mapping” using the Modbus Utility.





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3.3 EZ Data Logger

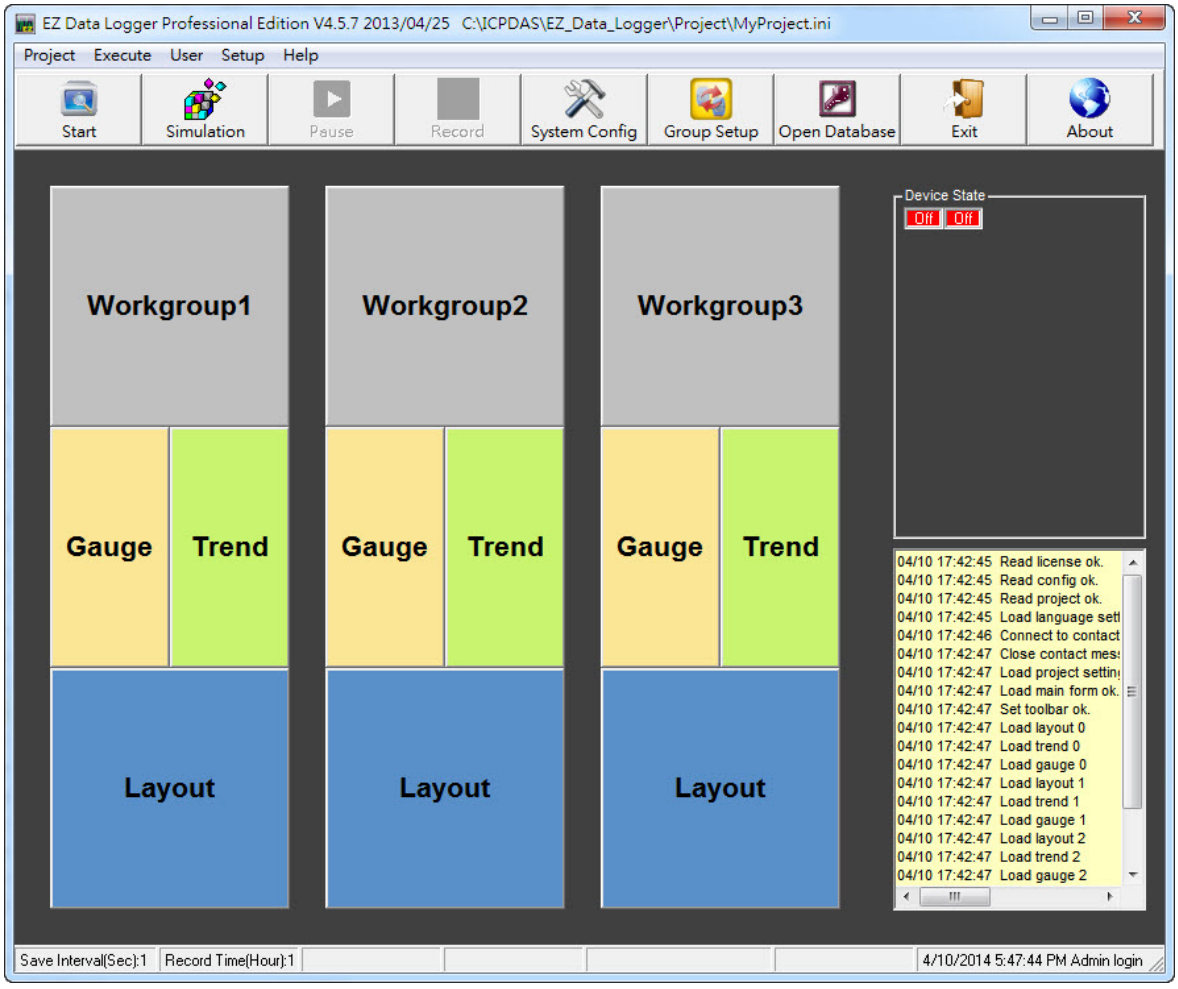
In this section, a detailed description of the procedure for connecting the EZ Data Logger solution to the controllers via the Modbus/TCP protocol is presented. In this example, EZ Data Logger version 4.5.7 is used.

Before you using the EZ Data Logger, the controller should be correctly configured using the Modbus Utility. The Net ID is set using the 8-bit DIP switch located on the right-hand side of the controller (see Section 2.4 Net ID (Station number) Setting for more information).

The EZ Data Logger can be downloaded from the following website:
http://ftp.icpdas.com/pub/cd/8000cd/napdos/driver/ez_data_logger/

3.3.1. Adding the I/O Modules to the Workgroup

Step 1: Open the EZ Data Logger software and the main page will be displayed. The EZ Data Logger will load a default project named "MyProject".



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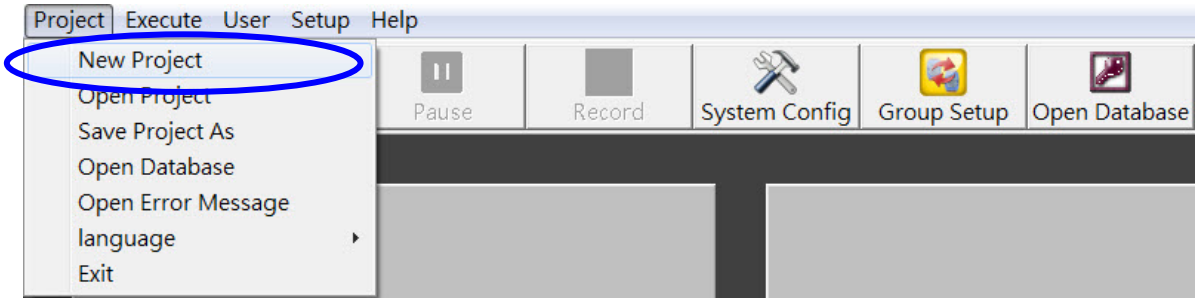
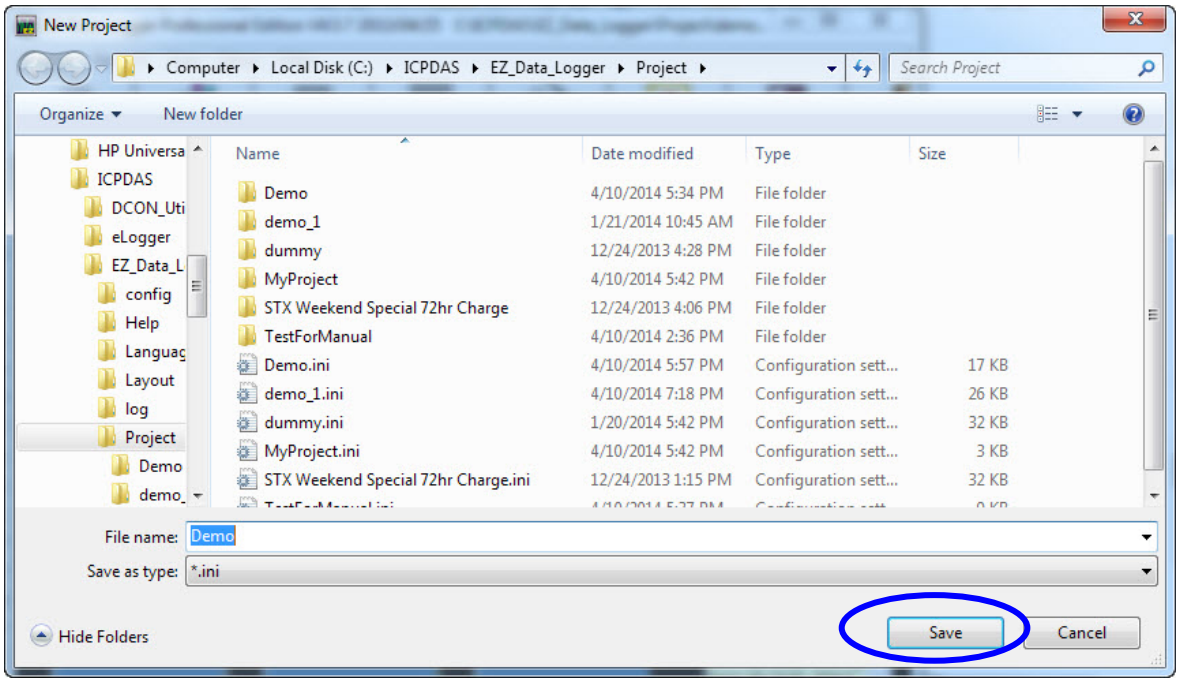
To create a new project, click “New Project” in the “Project” menu.



Step 2: Enter a name for the project and click the “Save” button.



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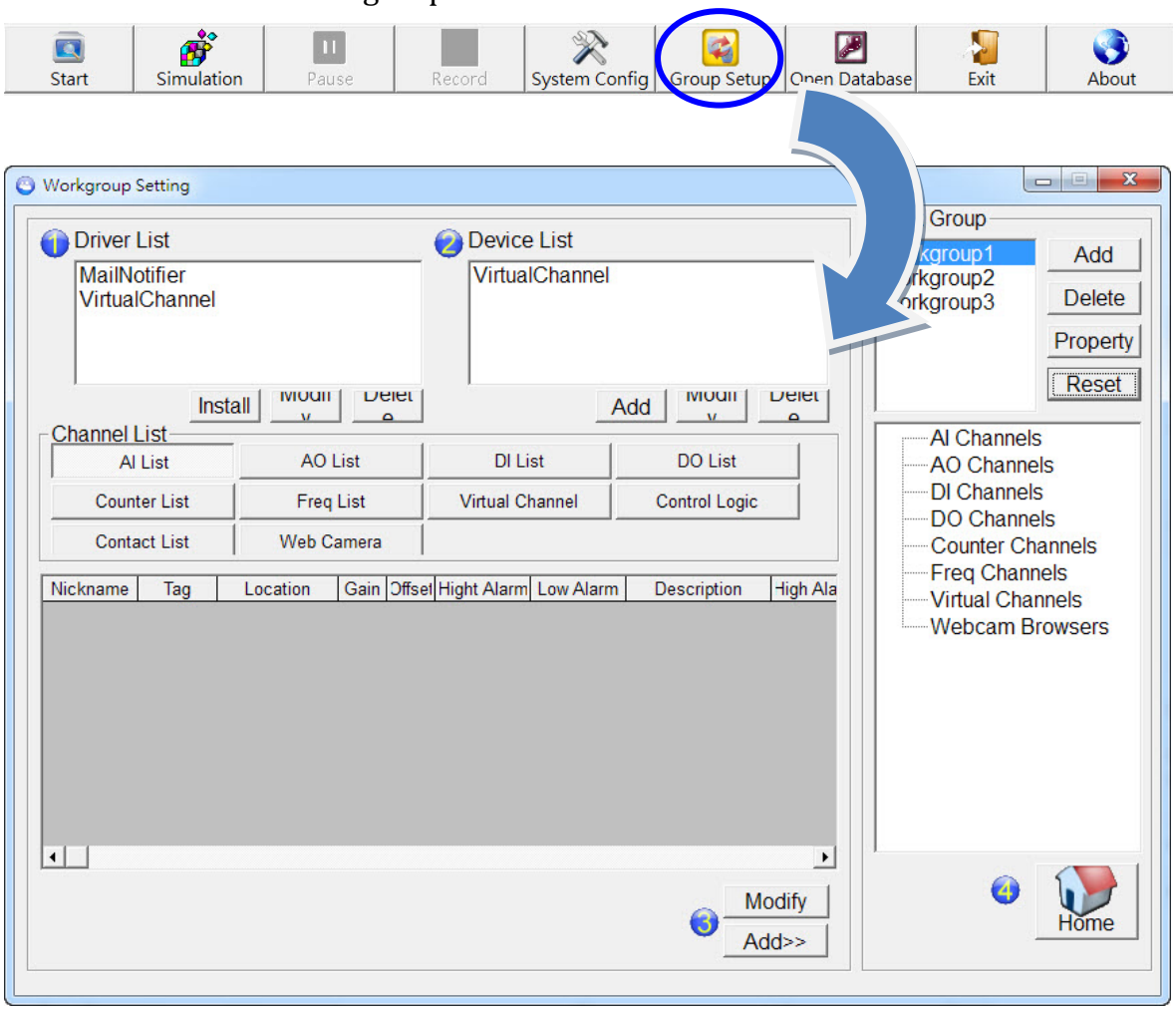
Step 3: Click the "Group Setup" button on the main toolbar to open the "Workgroup Setting" dialog box, and begin to add the controller and the I/O channels to the workgroup list.



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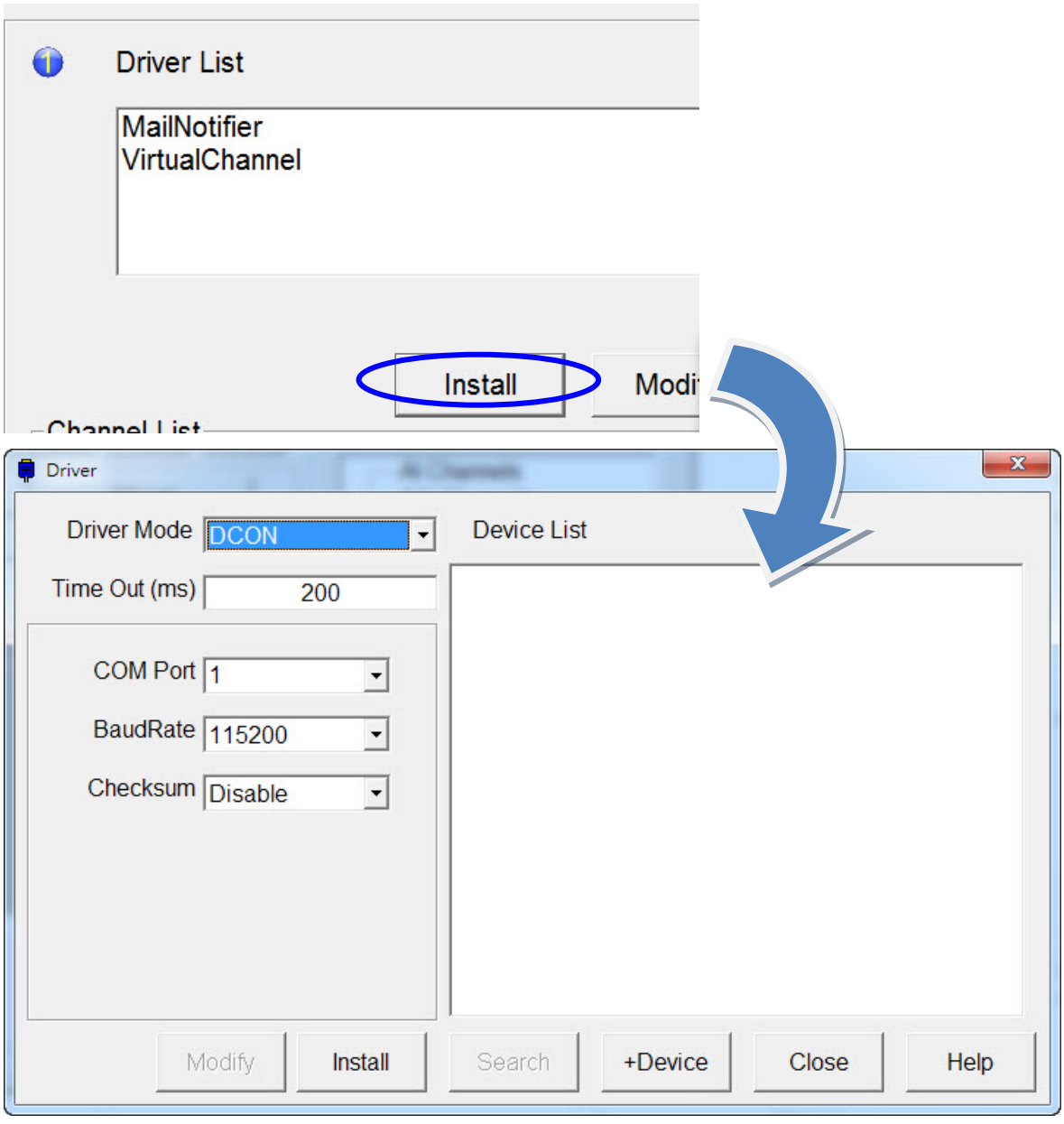
Step 4: Click the “Install” button in the “Driver List” numbered 1section to display the “Driver” dialog box.



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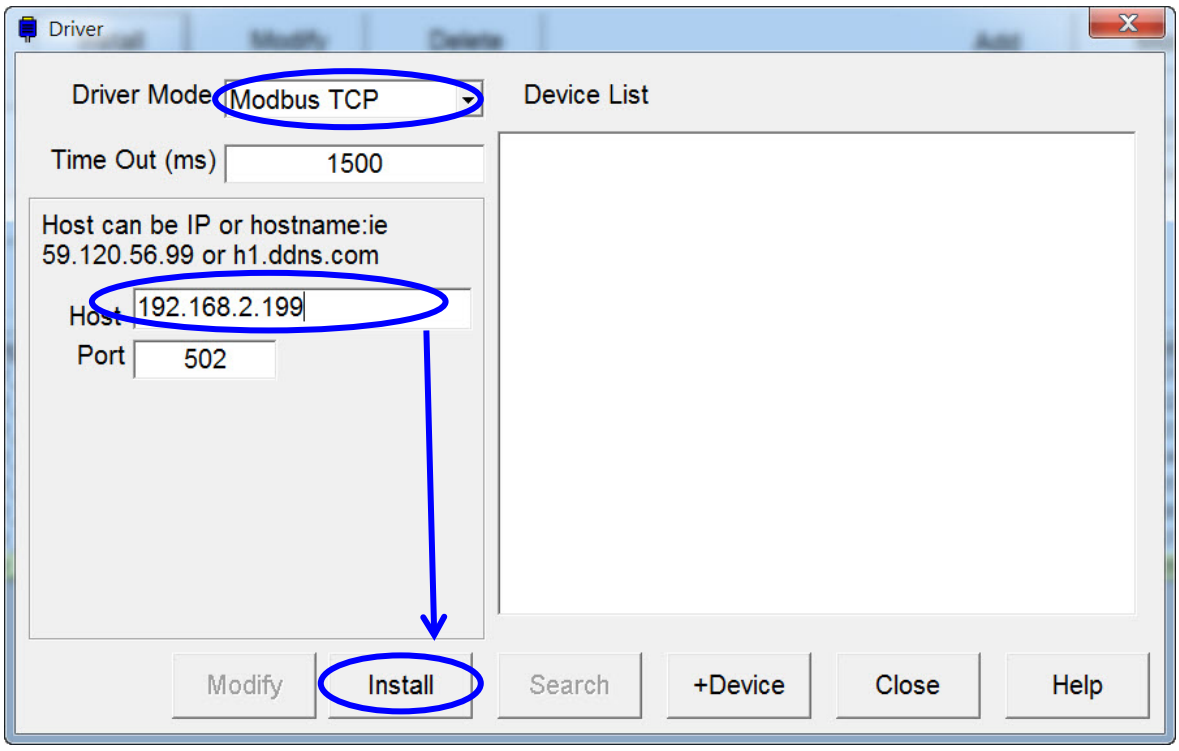
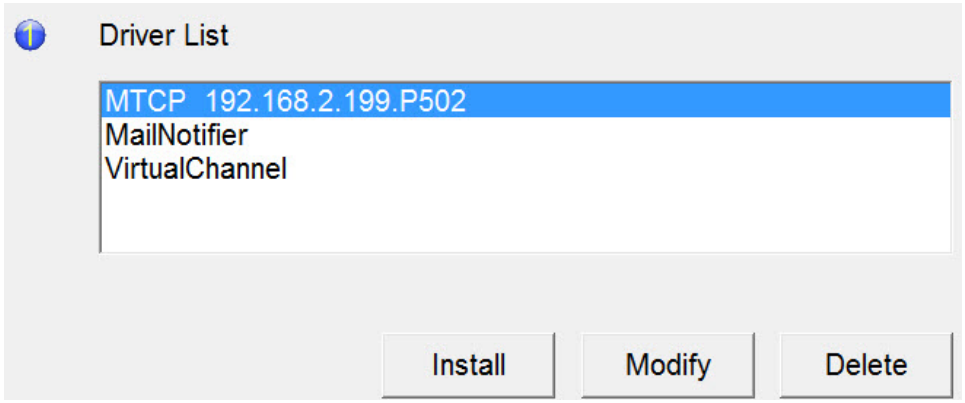
Step 5: Select "Modbus TCP" from the "Driver Mode" drop-down menu, and enter the controller IP address in the "Host" text field and then click the "Install".



The new driver will be added to the Driver List, as shown below.



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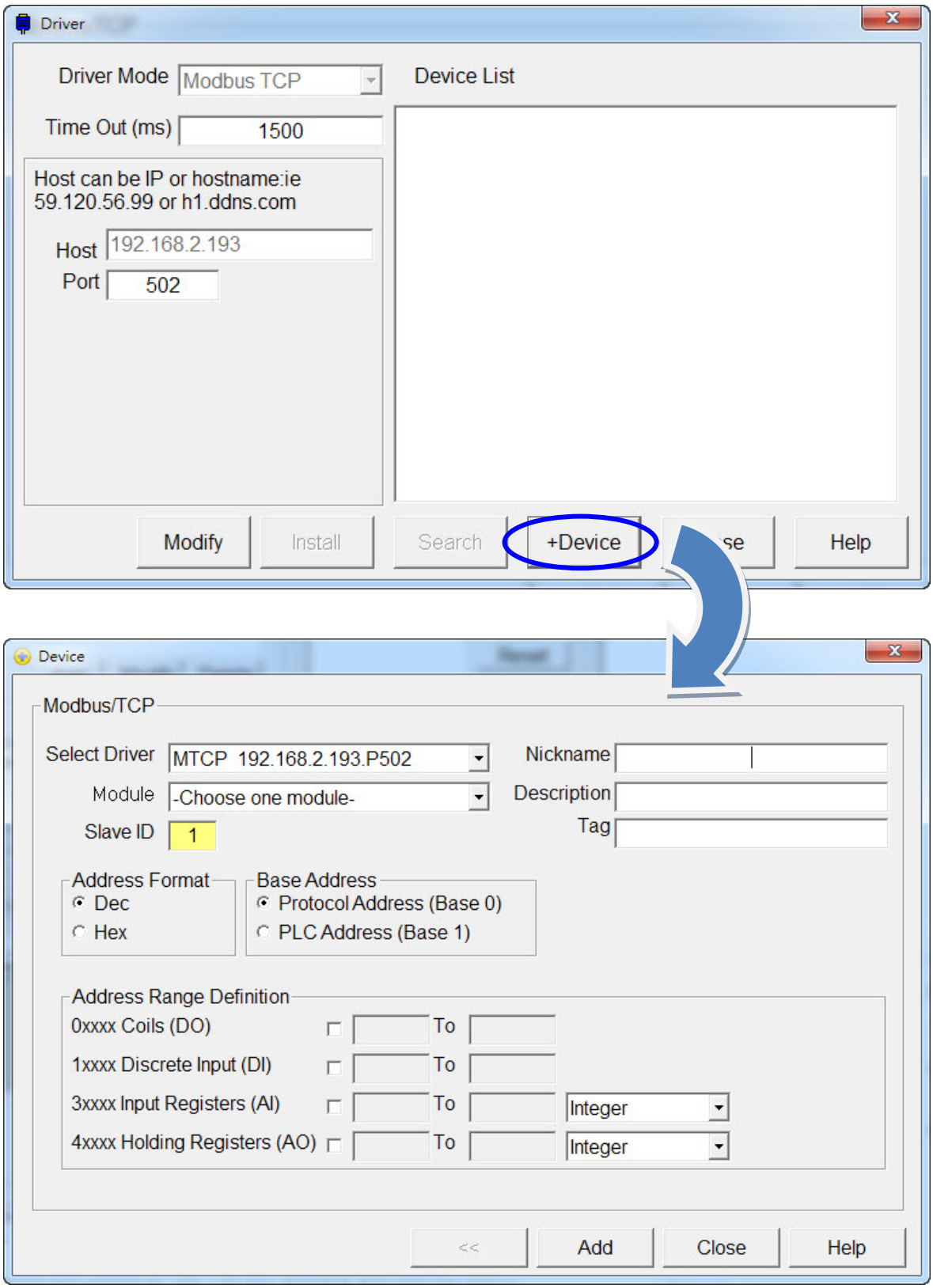
Step 6: Click the "+Device" button in the "Driver" dialog box to display the "Device" dialog box.



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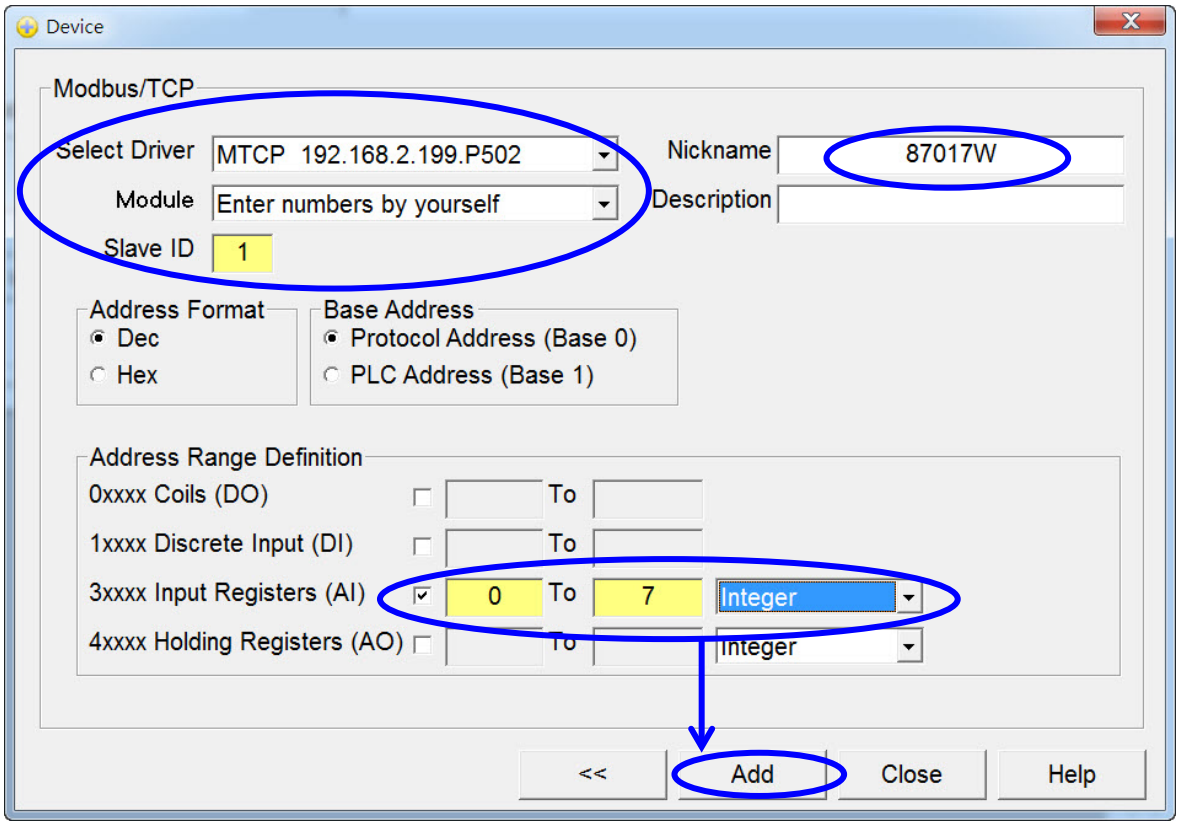
Step 7: In the "Select Driver" drop-down menu, select the "MTCP" driver that was added earlier and select "Enter numbers by yourself" from the "Module" drop-down menu.

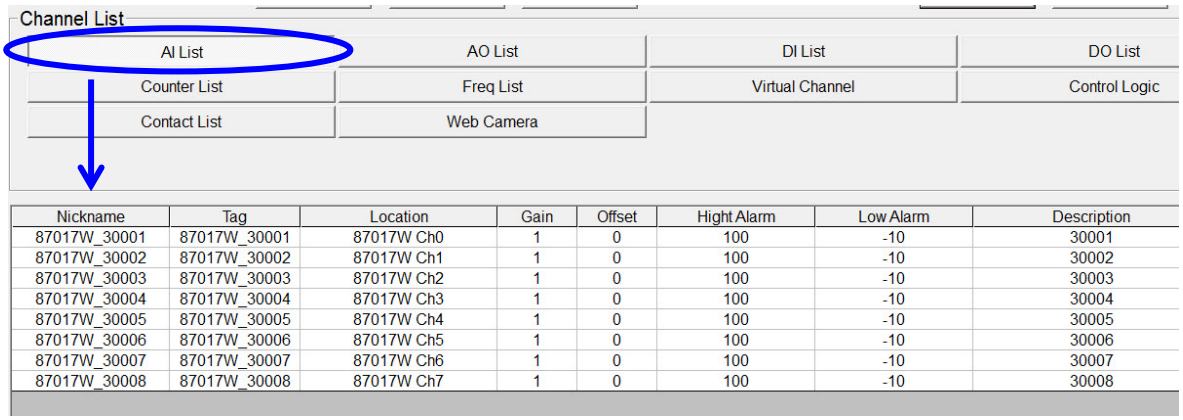
Enter the name of the AI module, 87017W in this example, in the "Nickname" text field of Nickname and set the "Slave ID" to "1".

Check the "AI" checkbox and enter the channel numbers 0 to 7 then select "Integer" as the type.

Click the "Add" button to add the new module configuration to the Device List section and Channel List section.



Once the new device has been configured, the new channels will be displayed in the "Channel List" section, as shown in the following figure.



Nickname	Tag	Location	Gain	Offset	Hight Alarm	Low Alarm	Description
87017W_30001	87017W_30001	87017W Ch0	1	0	100	-10	30001
87017W_30002	87017W_30002	87017W Ch1	1	0	100	-10	30002
87017W_30003	87017W_30003	87017W Ch2	1	0	100	-10	30003
87017W_30004	87017W_30004	87017W Ch3	1	0	100	-10	30004
87017W_30005	87017W_30005	87017W Ch4	1	0	100	-10	30005
87017W_30006	87017W_30006	87017W Ch5	1	0	100	-10	30006
87017W_30007	87017W_30007	87017W Ch6	1	0	100	-10	30007
87017W_30008	87017W_30008	87017W Ch7	1	0	100	-10	30008

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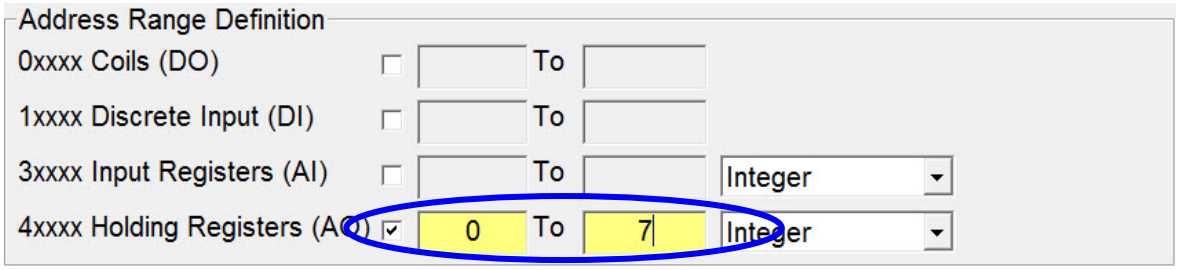
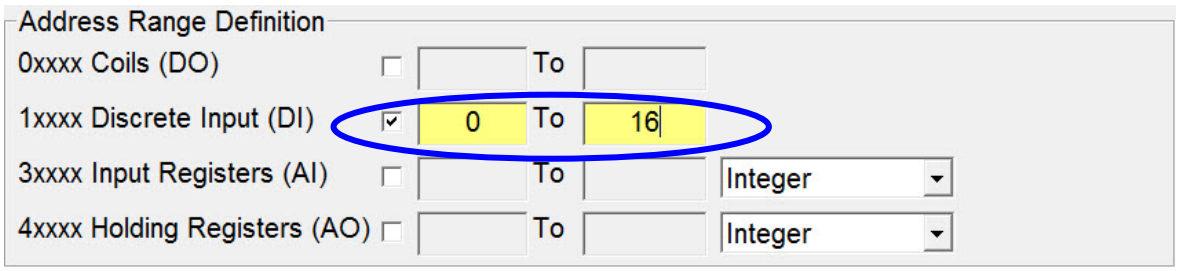
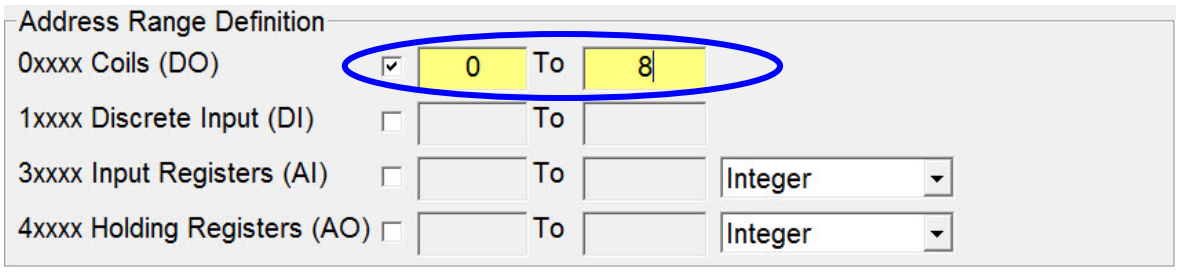
Step 8: As the "Device" dialog box remaining on the screen, using the images below as a guide, repeat the procedure described in Step 6 to add the details for AO, DI and DO to the Channel List.







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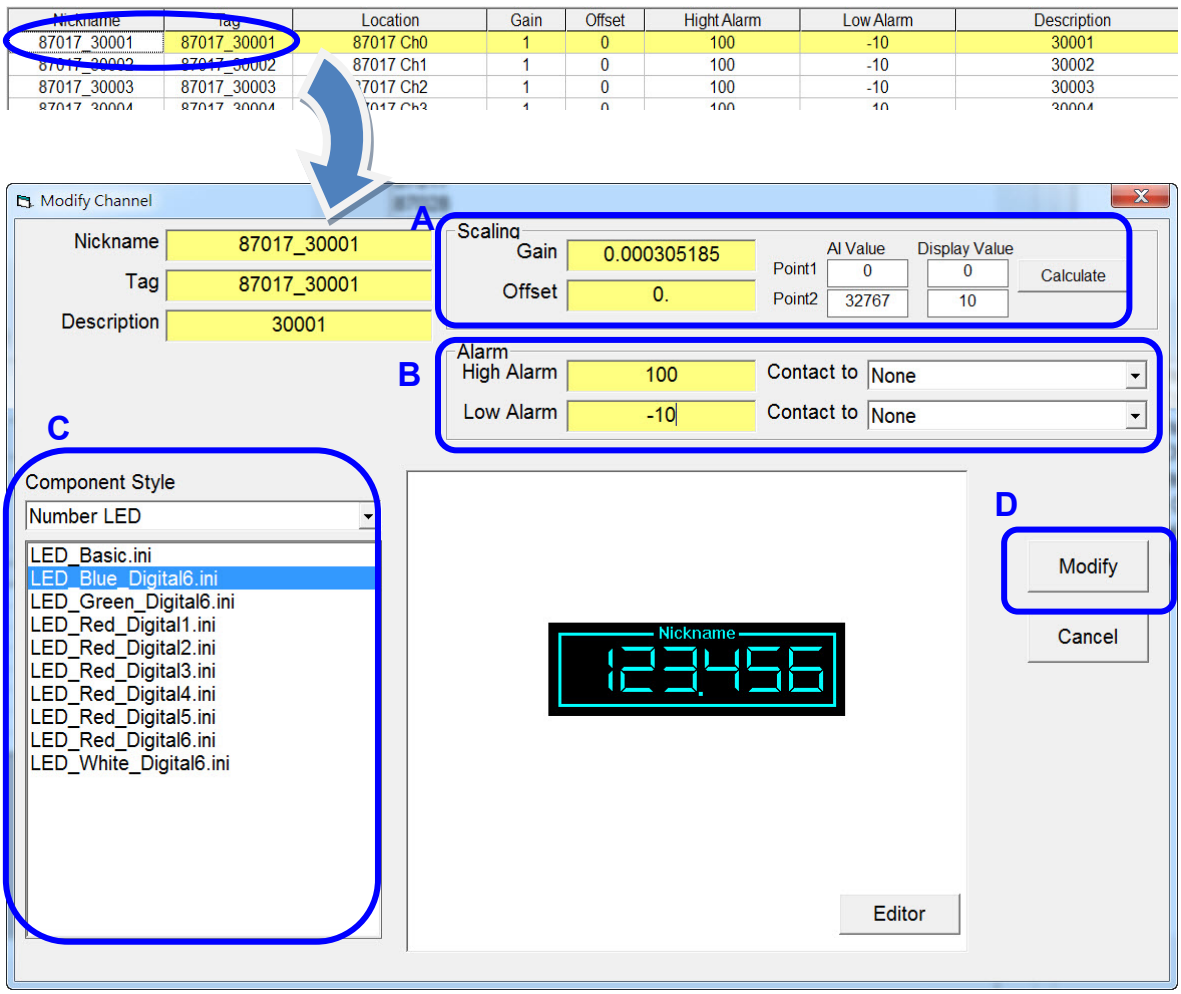
Step 9: The output style and alarm for an AI channel can be edited by double-clicking the name of the channel in the Channel List to open the "Modify Channel" dialog box. The example illustrated below uses AI channel 0. AO, DI and DO channel can be edited in the same way.



Configure the channel properties in the "Modify Channel" dialog box.

A. Set the Gain and Offset values by entering the AI value in the "Scaling" section.

B. In the "Alarm" section, set the high and low alarm values to notify of any abnormal events if the "MailNotifier" driver was set earlier. The procedures to set "MailNotifier" can be gotten from below download link: http://ftp.icpdas.com/pub/cd/8000cd/napdos/driver/ez_data_logger/faq_en/ezdl1-003-03_how_to_set_alarm_notifies_by_sending_email_en.pdf

C. In the "Component Style" section, select the desired style for AI channel 0.

D. Click the "Modify" button to save the configurations.

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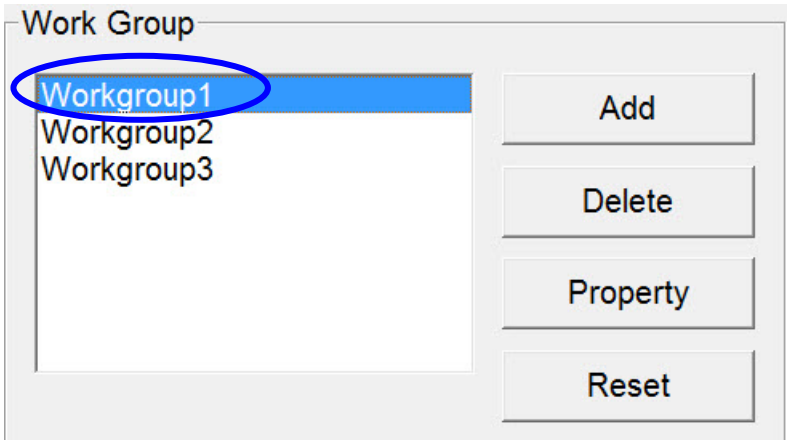
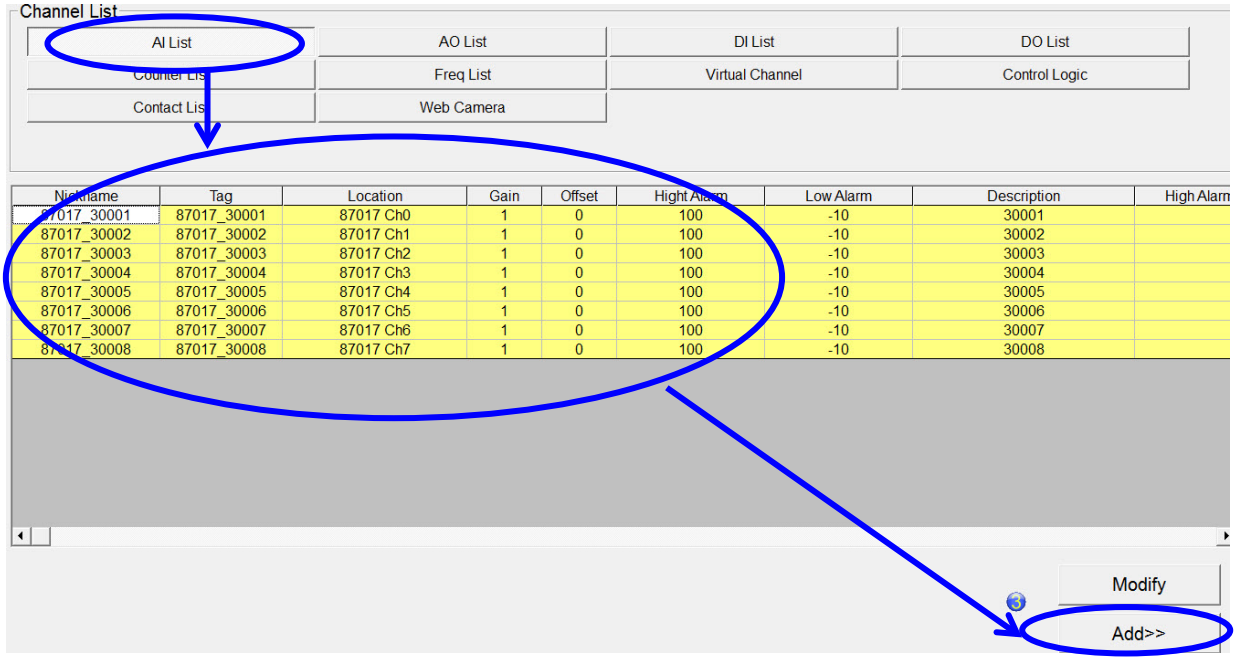
Step 10: Click" Workgroup1" to be a selected status from the "Work Group" section, and the I/O channels will be added to the channel list of the "Workgroup1" in the later procedures.



Step 11: Click the "AI List" button in the "Channel List" section to display the AI channels that configured earlier. Select all AI channels and click the "Add>>" button.



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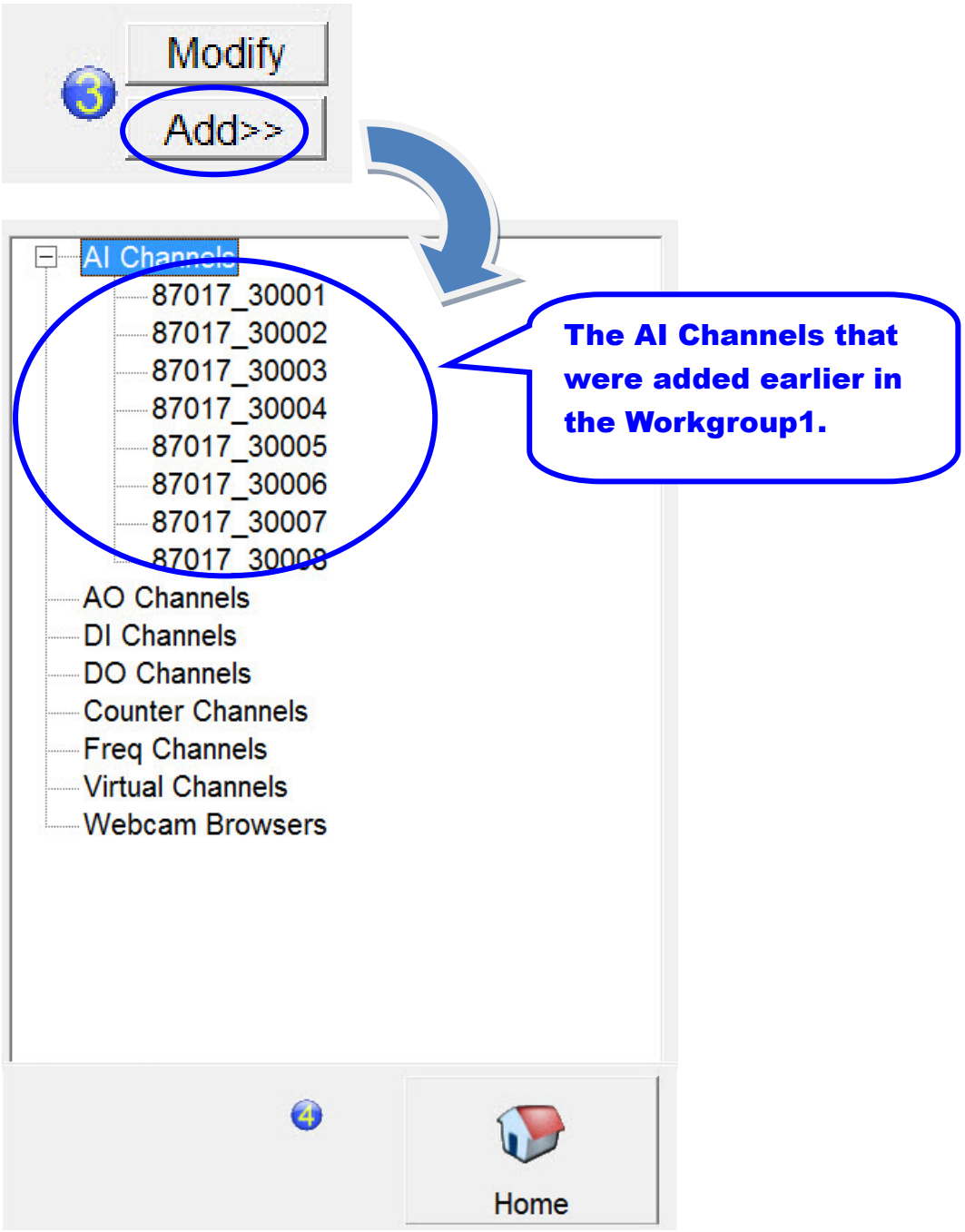
After clicking the "Add>>" button, the selected channels will be added to the channel list panel of the Workgroup1, as shown in the following figure. These channels will be used for monitoring purpose later.



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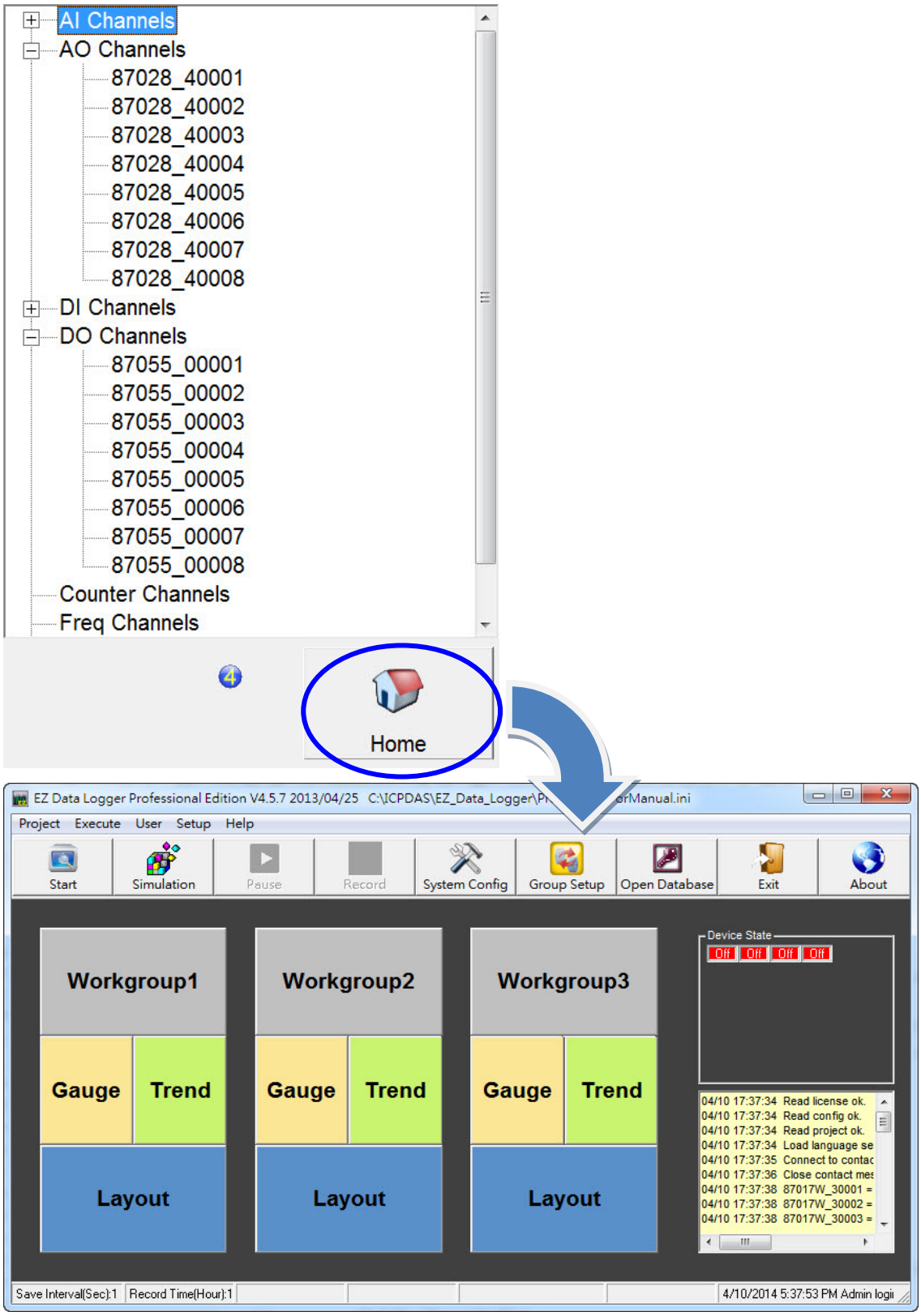
Step 12: Repeat the procedure described in Step 10 to add the other I/O channels to the channel list of Workgroup1. After all channels have been added, click the "Home" button to return to the main page.



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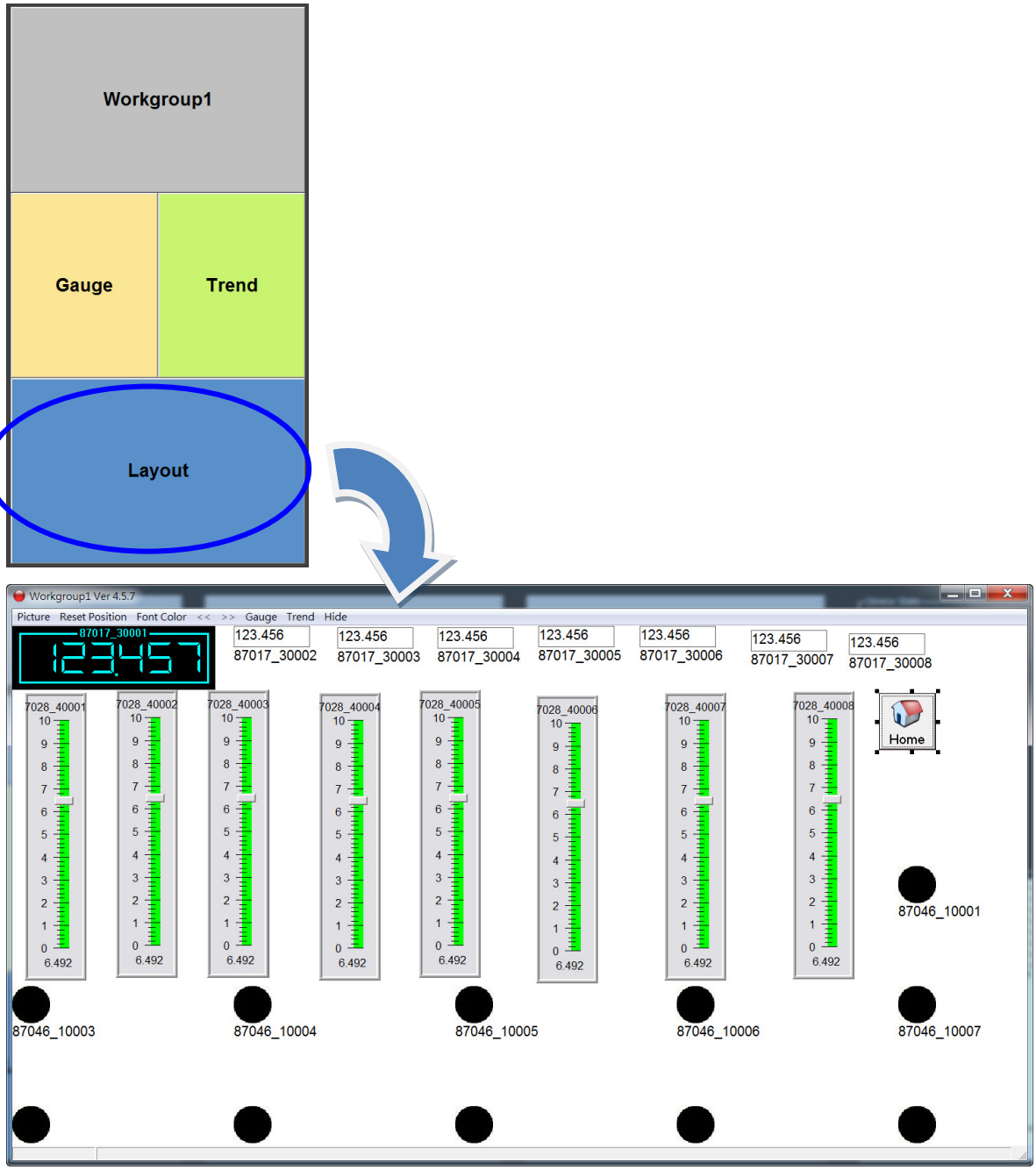
3.3.2. Designing the Layout and Acquiring the Data

After setting up in the section3.3.1, the layout can be designed and the data can be acquired in the main page.

Step 1: The layout style can be adjusted in the "Workgroup1 Ver 4.5.7" dialog box by clicking "Layout" button on "Workgroup1" in the main page.



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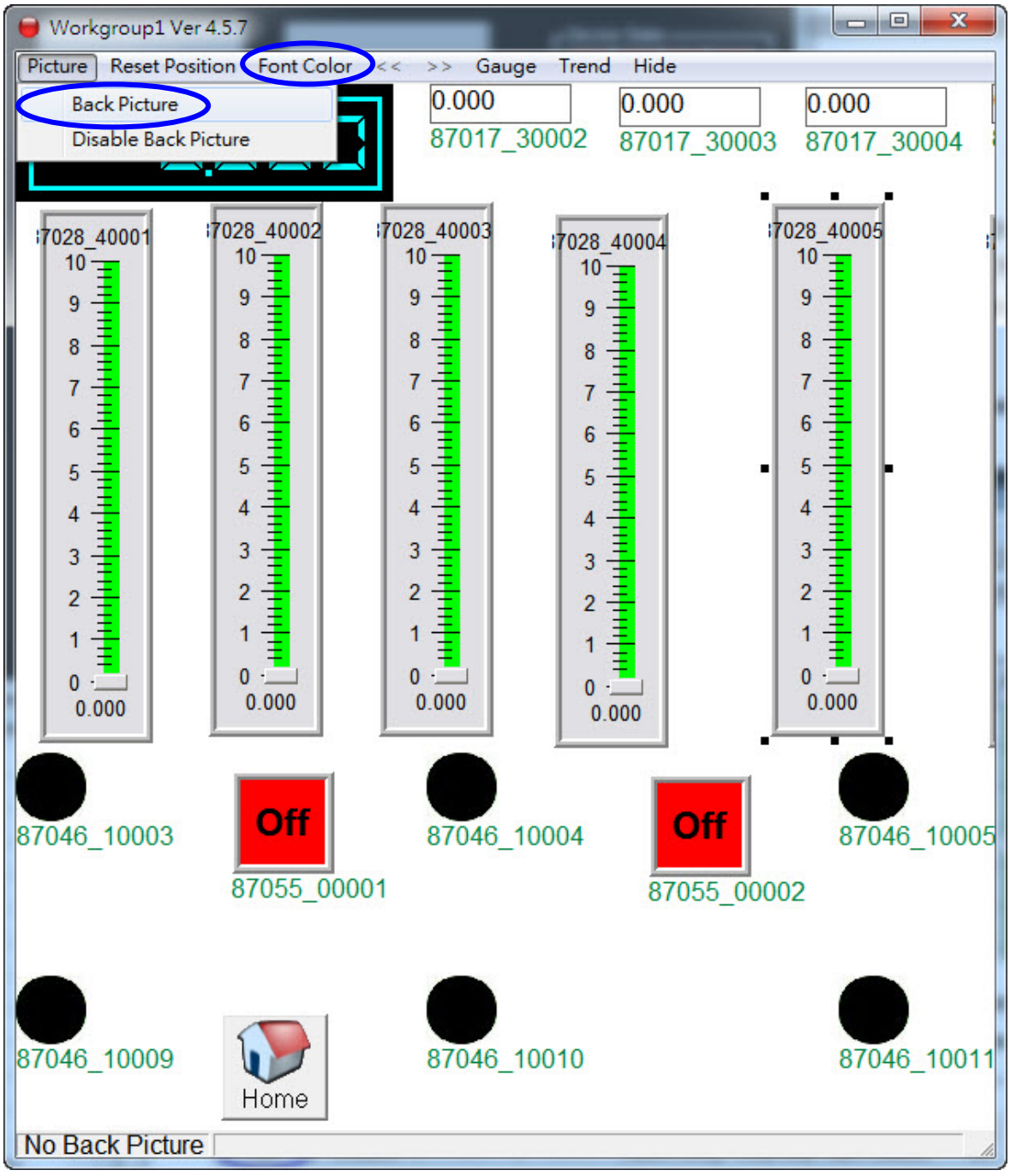
Step 2: The interface can be arranged by dragging the relevant I/O objects, adding a background by clicking the “Back Picture” from the “Picture” menu, or changing the font color by clicking the “Font Color” menu.



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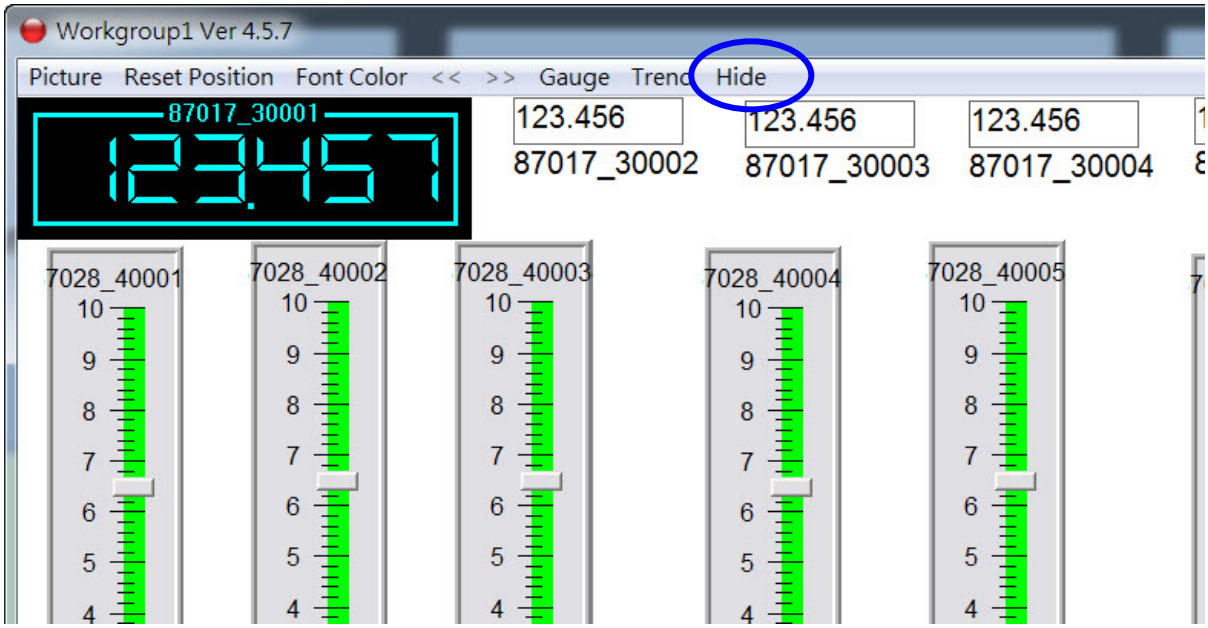
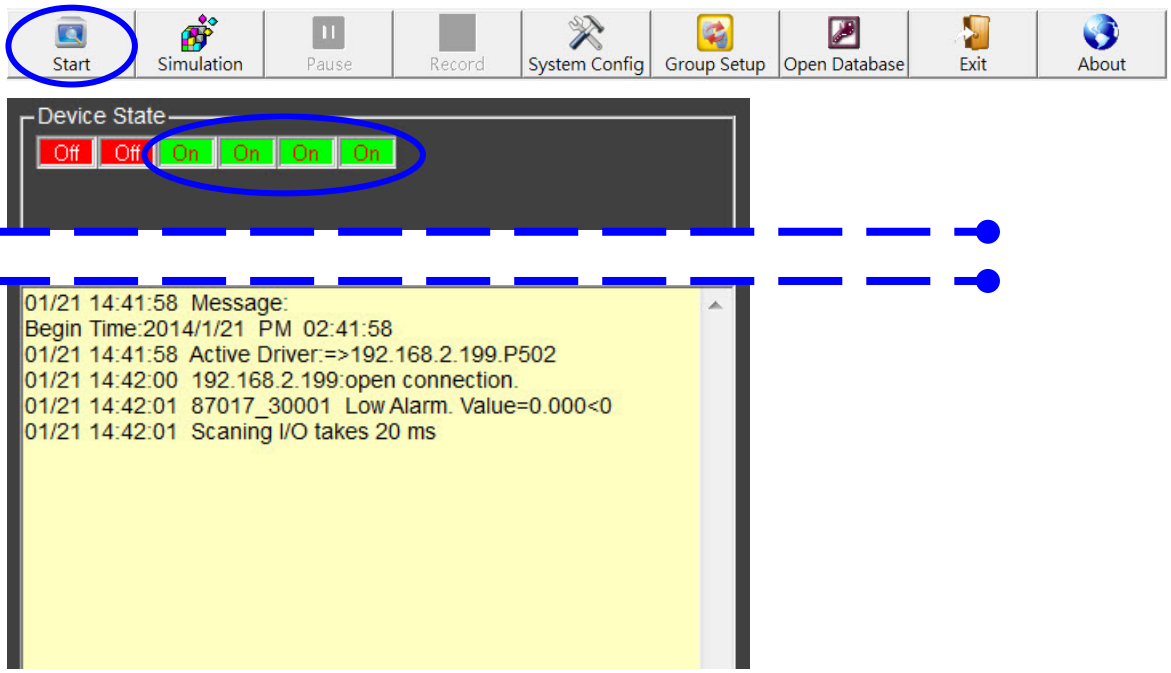
Step 3: After the interface design is complete, click the "Hide" button in the menu to close the dialog box.



Step 4: Click the "Start" button on the main toolbar to begin connecting to the controller and acquiring the values. If the connection has been correctly established, the device state indicators will be switched to ON and the connected messages will be printed in the yellow text filed.



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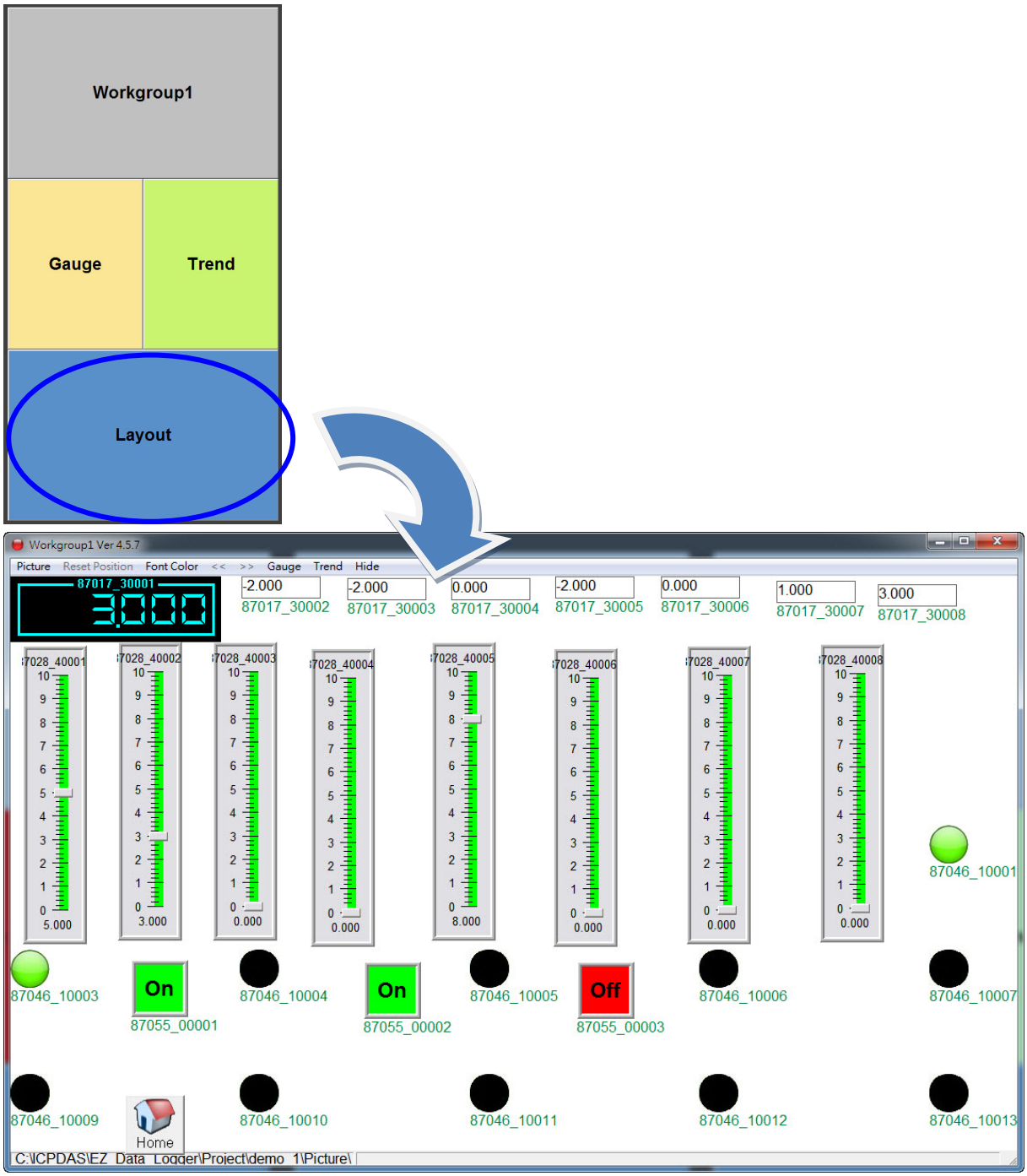
Step 5: To acquire the I/O values, the “Gauge” button, the” Trend” button or the” Layout” button can be clicked. The “Layout” button is clicked in the following figures. The”Workgroup1 Ver 4.5.7” dialog box will be displayed, and the values from the relevant modules also be displayed in the dialog box.



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Appendix A: Backing Up and Recovering the EEPROM Settings

The EERPOM is a memory component that is used to store network, system, COM port and module configuration information .The Back Up/Recover functions are used to duplicate EEPROM data from one controller to another.

The size of the EEPROM is different in every controller and each block in the EEPROM stores different types of data. The following table givens an overview of the writable blocks and the reserved blocks. The writable blocks include library version, COM port configuration, watchdog timer, module settings, and the reserved blocks include IP address, Mask, Gateway and MAC address.

Controller	Writable Block	Reserved Block	Number of Blocks
I-8000	1-7	0	8 (blocks 0-7)
IP-8000	8-14	0-7	64 (blocks 0-63)
7188E	1-7	0	8 (blocks 0-7)

Note 1: Before attempting to read or write EEPROM data, ensure that the I/O Scan Library is version 1.6.0 or later.

Note 2: This function only supports connections via the COM port. Before attempting to perform this function, ensure that controller's COM1 is connected to the computer.

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1. Backing up the Settings

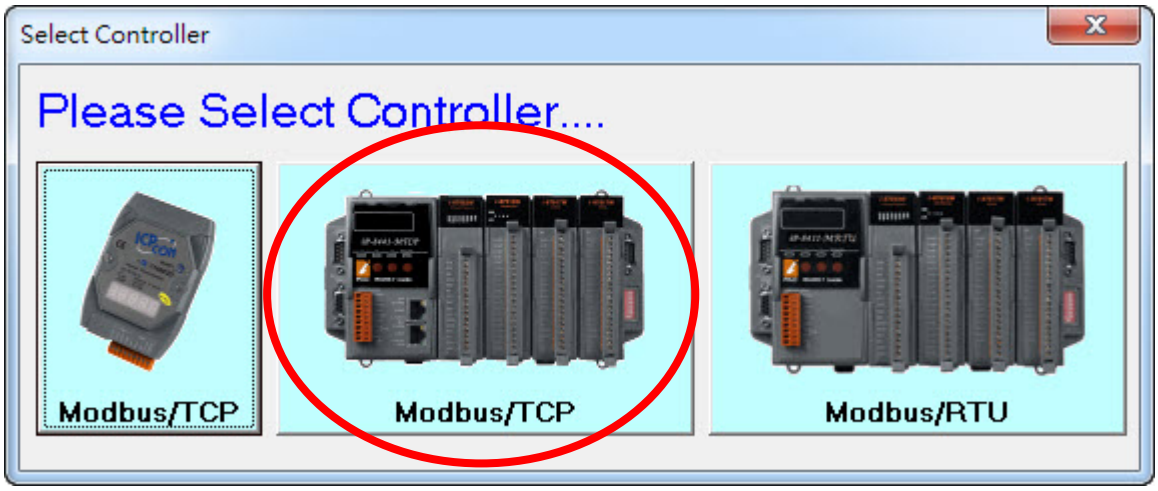
Step 1: Reboot the controller in INIT mode.

For I-8000 modules, short the INIT* and INIT*COM pins.

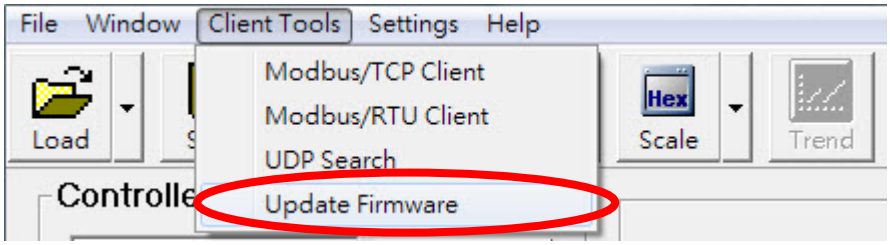
For IP-8000 modules, move the DIP switch to the "Init" position.

For 7188E devices, short the INIT* and GND pins.

Step 2: Execute the Modbus Utility and select the Modbus/TCP mode.



Step 3: Select the "Update Firmware" option from the "Client Tools" menu to connect to the controller.



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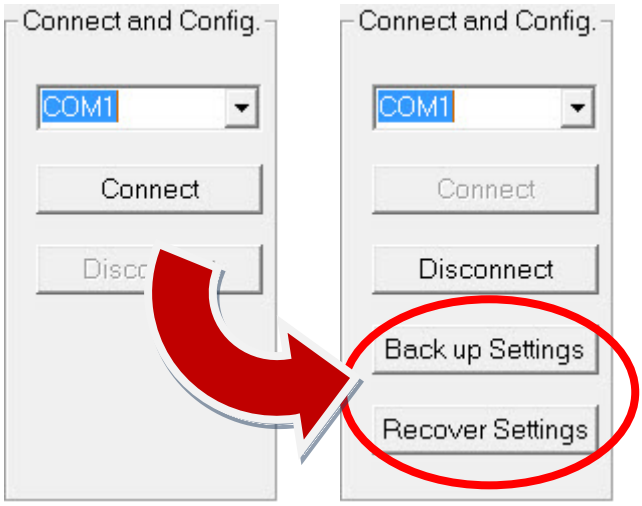
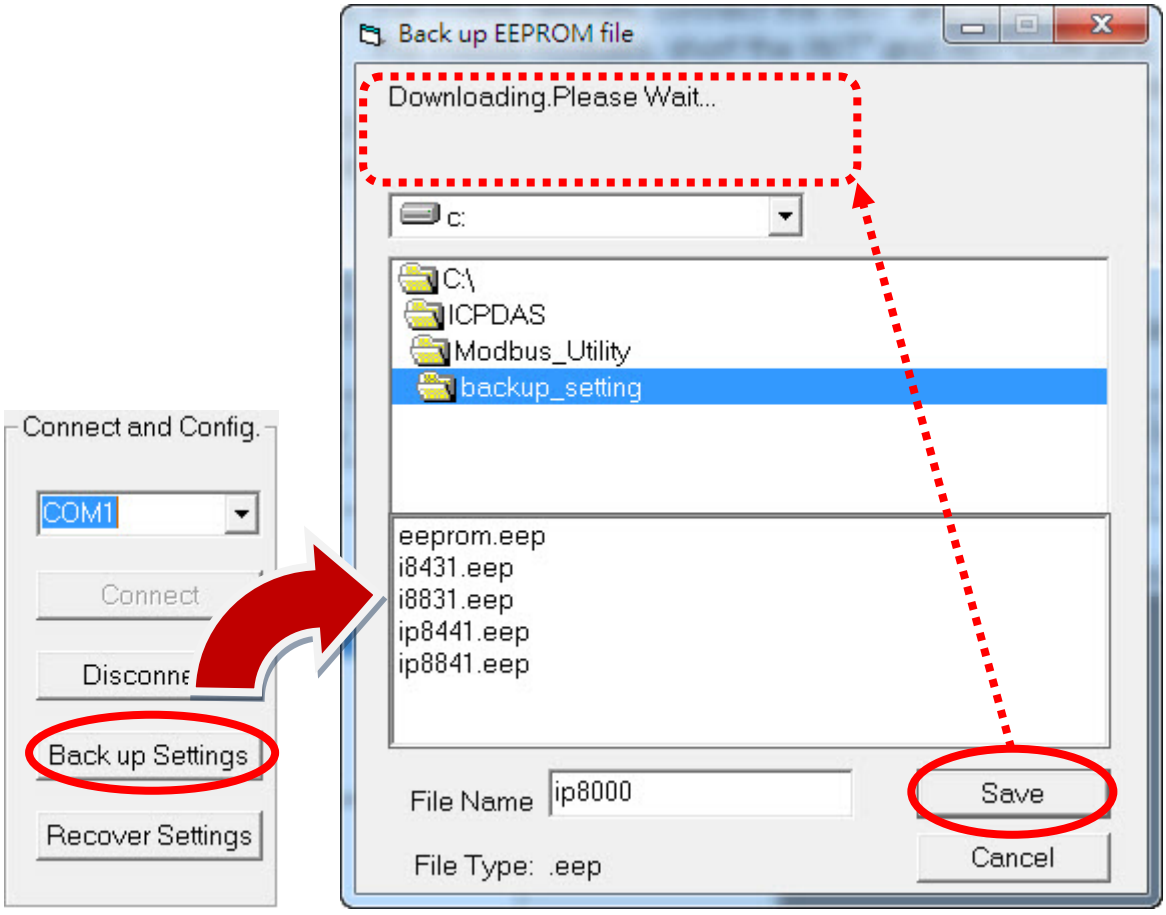
Select the COM port from the drop-down menu and then click the “Connect” button. Once a connection is established, the “Back up Settings” and “Recover Settings” buttons will be displayed.



Step 4: Click the “Back up Settings” button and the “Back up EEPROM file” dialog box will be displayed. Click the "Save" button to save the current configuration of the controller to the default root folder named “backup_setting”. A status message "Downloading. Please Wait..." will be displayed while the file is saved.



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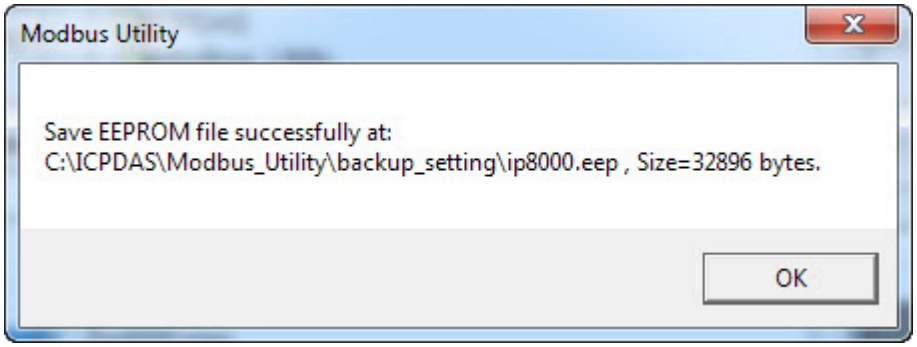
Once the download is complete, a message will be displayed to notify that the file was saved successfully. Click the "OK" button to continue.



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2. Recovering the Settings

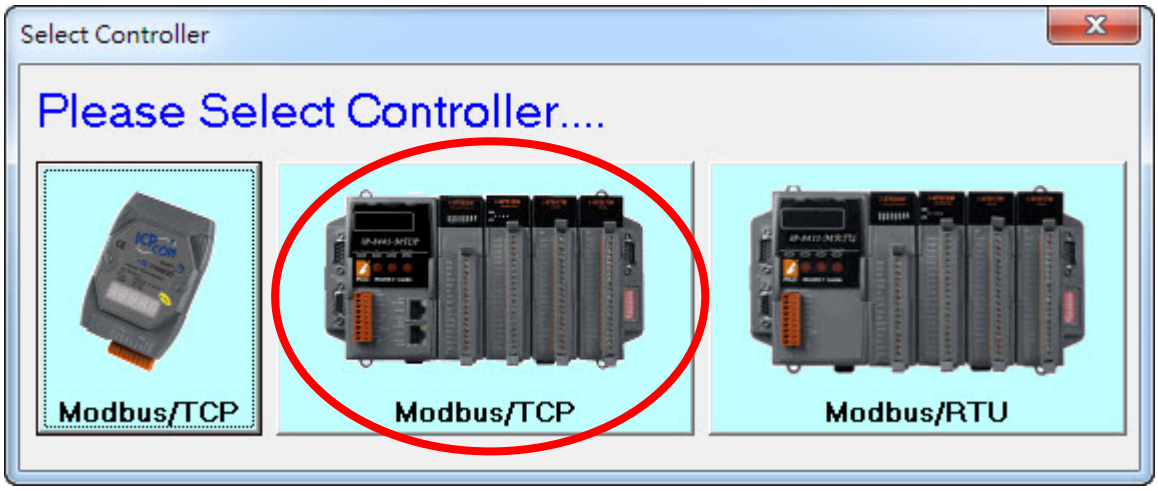
Step 1: Reboot the controller in INIT mode.

For I-8000 modules, short the INIT* and INIT*COM pins.

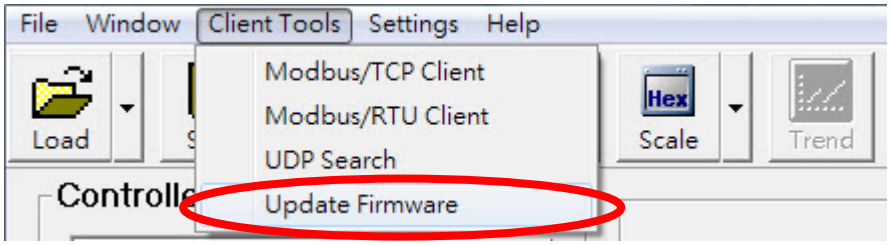
For IP-8000 modules, move the DIP switch to the “Init” position.

For 7188E devices, short the INIT* and GND pins.

Step 2: Execute the Modbus Utility and select the Modbus/TCP mode.



Step 3: Select the “Update Firmware” option from the “Client Tools” menu to connect to the controller.



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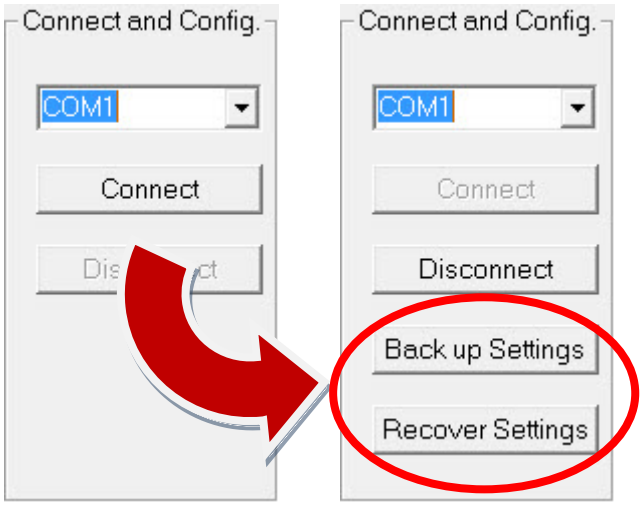
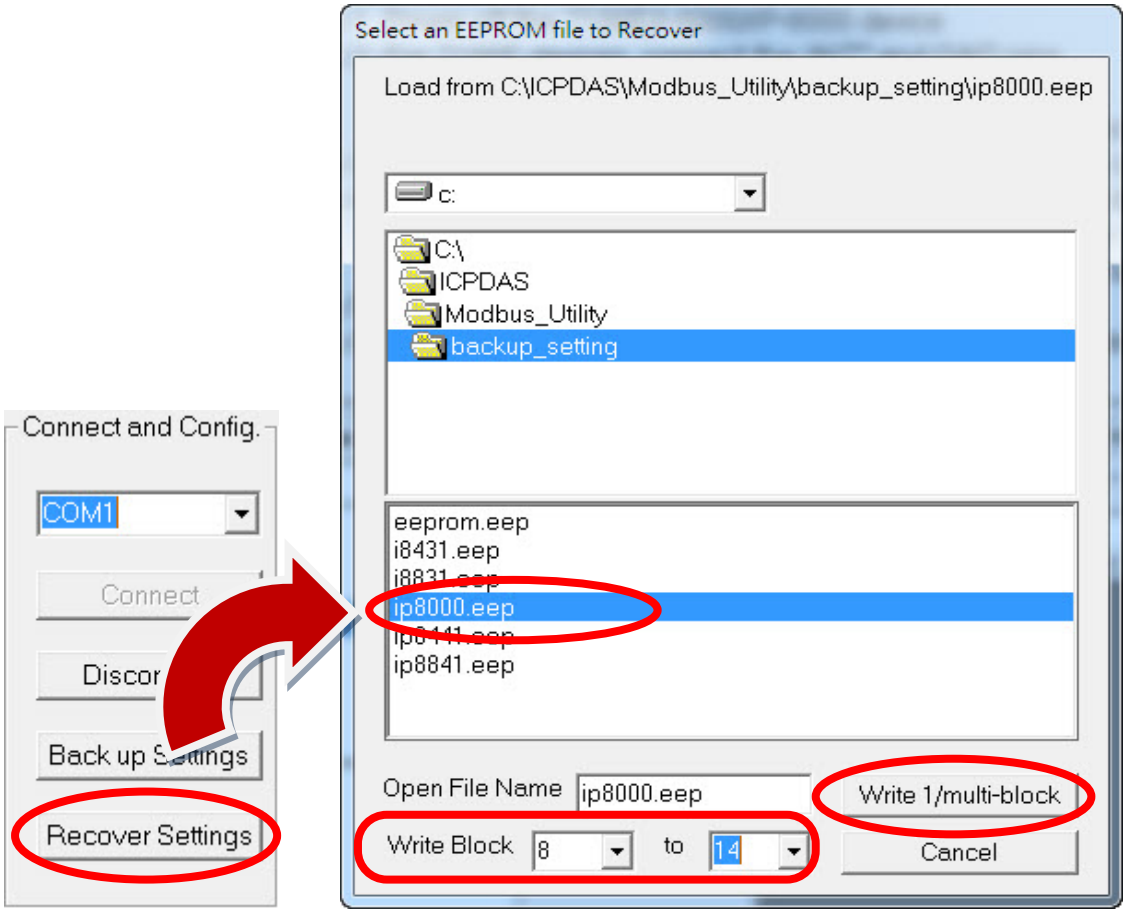
Select the COM port from the drop-down menu and then click the “Connect” button. Once a connection is established, the “Back up Settings” and “Recover Settings” buttons will be displayed.



Step 4: To configure a controller to the same settings as another, click the “Recover Settings” button and the "Select an EEPROM file to write" dialog box will be displayed. Click the name of the file that contains the configuration to be uploaded, and then select the blocks to be duplicated from the "Write Block" drop-down menus, then click the "Write 1/multi-block" button.



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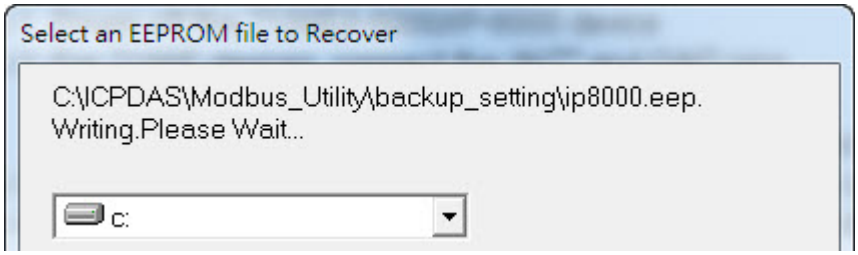
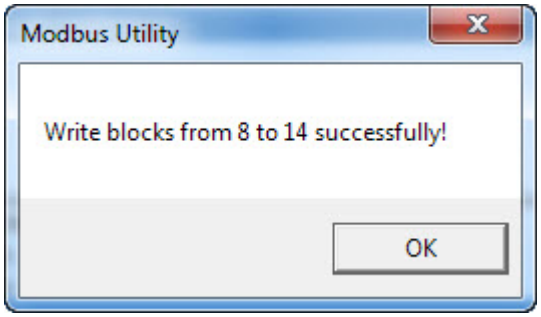
A status message "Writing. Please Wait..." will be displayed while the configuration is duplicated.



Once the duplication process is complete, a message will be displayed to notify that the file was written successfully. Click the "OK" button to continue.



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Appendix B: Function Codes (FC)

All data addresses in a Modbus message **start at zero** and are transmitted **in hexadecimal** format. For example:

A. Input register 30001 is addressed as 0 in the data address field of the Modbus message.

B. Coil 24 (decimal) in an I/O module is addressed as coil 0017 (hexadecimal) in the Modbus message (Equivalent to 23 in decimal.).

As the function code already specifies whether the operation is DO, DI, AO or AI, the references '0xxxx, 1xxxx, 4xxxx, 3xxxx' are implicit. Function codes are used in both the Modbus RTU Master Tool and the Modbus TCP Client Tool.

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1. Read DO (0xxxx)

Function Code 01=Read Coil Status

Request								
Byte			0	1	2	3	4	5
			Net ID	FC=01	Starting Address		Bit Count	
Example: Net ID = 20(*1), Read coils 18-30(*2)		Hex	14	1	0	11	0	D
		Command		14 1 0 11 0 D				

Response					
Byte	0	1	2	3	~Byte Count+2
	Net ID	FC=01	Byte Count	Bits Value	
Response	14	01	2(*3)	5C (coils 25-18)	1B (coils 30-26)
Binary				0101 1100(*4)	0001 1011(*5)

*1: Net ID decimal 20 = hexadecimal 14.

*2: Coils 18-30 are addressed as 17-29 (decimal), with a total of 13 coils.

*3: If the number of coils returned isn't a multiple of 8, the remaining bits in the last byte will be filled with 0.

*4: 5C= 0101 1100 refers to coils 18 to 25 (from right to left). The status values are: OFF (25), ON (24), OFF (23), ON (22), ON (21), ON (20), OFF (19), OFF (18).

*5: 1B= 0001 1011, refers to coils 26 to 30 (from right to left). The status values are: ON (30), ON (29), OFF (28), ON (27), ON (26).

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2. Read DI (1xxxx)

Function Code 02=Read Input Status

Request								
Byte		0	1	2	3	4	5	
		Net ID	FC=02	Starting Address		Bit Count		
Example: Net ID = 1, Read the input status 1-8(*1)	Hex	1	2	0	0	0	8	
	Command	1 2 0 0 0 8						

Response					
Byte	0	1	2	3	~Byte Count+2
	Net ID	FC=02	Byte Count	Bits Value	
Response	1	2	1	FF (coils 8-1)	
Binary				1111 1111(*2)	

*1: Inputs 1-8 are addressed as 0-7 (decimal), there are a total of 8 inputs.

*2: FF=1111 1111, refers to coils 8 to 1 (from right to left), and the status of each coil is set ON.

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3. Read AO (4xxxx)

Function Code 03=Read Holding Registers

Request							
Byte		0	1	2	3	4	5
		Net ID	FC=03	Starting Address		Word Count	
Example: Net ID = 25, Read registers 40027-40028(*1)	Hex	19	3	0	1A	0	2
	Command	19 3 0 1A 0 2					

Response							
Byte	0	1	2	3		~Byte Count+2	
	Net ID	FC=03	Byte Count	Register Values			
Response	19	3	4	2	17	0	C8
Register				40027(*2)		40028(*2)	

*1: Holding registers 40027-40028 are addressed as 26-27 in Modbus.

*2: The value of register 40027 is shown as a 2-byte value: 02 17 (hexadecimal) = 535 (decimal), the value of register 40028 is 00 C8 (hexadecimal) = 200 (decimal). To convert value to float format, see Appendix D: Range Codes for Analog Modules.

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4. Read AI (3xxxx)

Function Code 04=Read Input Registers

Request							
Byte		0	1	2	3	4	5
		Net ID	FC=04	Starting Address		Word Count	
Example: Net ID = 2, Read registers 30001-30002(*1)	Hex	2	4	0	0	0	2
	Command	2 4 0 0 0 2					

Response							
Byte	0	1	2	3		~Byte Count+2	
	Net ID	FC=04	Byte Count	Register Values			
Response	2	4	4	0	0	0	64
Register				30001(*2)		30002(*2)	

*1: Input registers 30001-30002 are addressed as 0-1 in Modbus.

*2: The value of register 30001 is shown as a 2-byte value: 00 00 (hexadecimal) = 0 (decimal), the value of register 30002 is 00 64 (hexadecimal) = 100 (decimal). To convert value to float format, see Appendix D: Range Codes for Analog Modules.

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5. Write Single DO (0xxxx)

Function Code 05=Write Single Coil

Request							
Byte		0	1	2	3	4	5
		Net ID	FC=05	Write Address		FF 00=ON, 00 00=OFF	
Example: Net ID = 1, set coil 5 to ON(*1)	Hex	1	5	0	4	FF	0
	Command	1 5 0 4 FF 0					

Response						
Byte	0	1	2	3	4	5
	Net ID	FC=05	Write Address		FF 00=ON, 00 00=OFF	
Response	1	5	0	4	FF	0
If the request is successful, the function will return an echo of the request.						

*1: Coil 5 is addressed as 4.

A value of FF 00 sets the coil to ON, and a value of 00 00 sets it to OFF. All other values are treated as an invalid command.

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6. Write Single AO (4xxxx)

Function Code 06= Write Single Register

Request							
Byte		0	1	2	3	4	5
		Net ID	FC=06	Write Address		Register Value	
Example: Net ID = 1, set register 40003(*1) to 155(*2)	Hex	1	6	0	2	0	9B
	Command	1 6 0 2 0 9B					

Response						
Byte	0	1	2	3	4	5
	Net ID	FC=06	Write Address		Register Value	
Response	1	6	0	4	0	9B
If the request is successful, the function will return an echo of the request.						

*1: Register 40003 is addressed as 2 in Modbus.

*2: Register value 155 = 9B (hexadecimal).

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7. Write DO (0xxxx)

Function Code 15=Write Multiple Coils

Request									
Byte	0	1	2	3	4	5	6	7	~Byte Count+6
	Net ID	FC=15	Write Address		Bit Count		Byte Count	Data to be Written	
Hex	1	F	0	0	0	C	2	FE(*2)	05(*2)
Example: Net ID = 1, write coils 1 to 12(*1)								1111 1110	0000 0101
Command		1 F 0 0 0 C 2 FE 5							

Response						
Byte	0	1	2	3	4	5
	Net ID	FC=15	Write Address		Bit Count	
Response	1	F	0	0	0	C

*1: Coils 1-12 are addressed as 0-11, there are a total of 12(hexadecimal 0C) coils.

*2: The data is 2-byte value. FE 05 (hexadecimal) = 1111 1110 0000 0101 (binary)

Bit	1	1	1	1	1	1	1	0		0	0	0	0	0	1	0	1
Coil	8	7	6	5	4	3	2	1		-	-	-	-	12	11	10	9

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8. Write AO (4xxxx)

Function Code 16= Write Multiple Registers

Request											
Byte	0	1	2	3	4	5	6	7	~Byte Count+6		
	Net ID	FC=16	Write Address		Word Count		Byte Count	Register Values			
Hex	1	10	0	0	0	2	4	0	19	0	64
Example: Net ID = 1, write register 40001-40002(*1)			Command		1 10 0 0 0 2 4 0 19 0 64						

Response						
Byte	0	1	2	3	4	5
	Net ID	FC=16	Write Address		Word Count	
Response	1	10	0	0	0	2

*1: Register 40001-40002 are addressed as 0-1 in Modbus.
The register values are 40001:25 (hexadecimal 19), 40002:100 (hexadecimal 64).

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Appendix C: Supported Modules

For details of which I/O modules are supported by the different controllers, go to http://ftp.icpdas.com/pub/cd/8000cd/napdos/modbus/8000e/document/mbt8_support_modules.htm

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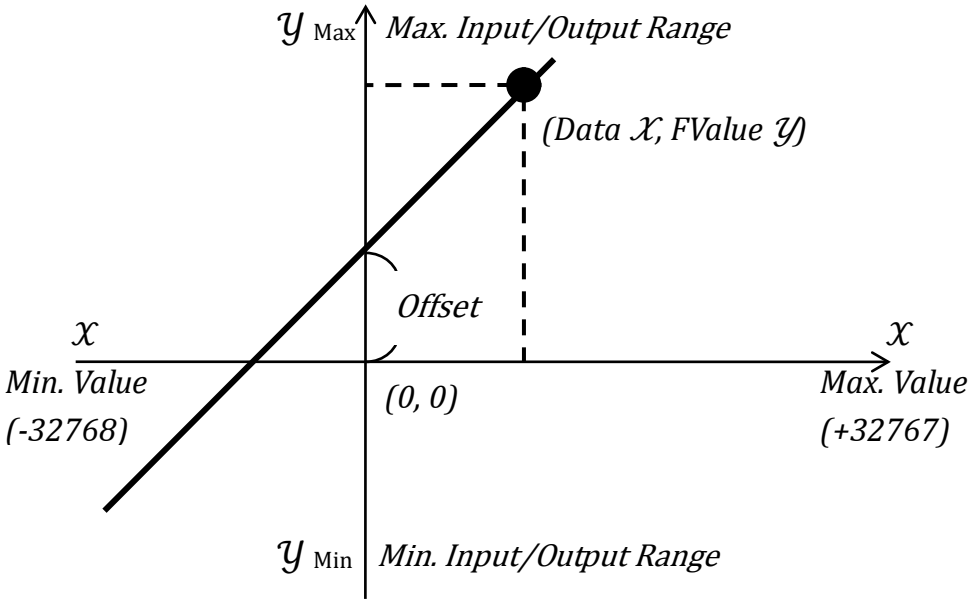
Appendix D: Range Codes for Analog Modules

The Modbus Utility can be used to convert the input or output value to float format or other formats. The operation can see Step 3 of 2.14Monitoring.
The formula shown below provides details of the conversion process.



Float Value Y = (Gain * Data X) + Offset
Gain = the Slope for this Range Code type.
Data = the input or output value.
Offset = the offset value to compensate for an inaccuracy in the module.

The following tables provide the maximum and minimum values, Gain, and Offset for each range code type.

- 87K Analog Modules
  - Current and Voltage Type Definitions
  - Thermocouple Type Definitions
  - RTD (Resistance Temperature Detector) Type Definitions
  - Thermistor Type Definitions
- 8K Modules

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1. 87K Analog Modules

1.1. Current and Voltage Type Definitions

Type Code	Type Definitions	Data Format	Max. Value	Min. Value	Gain	Offset
Analog Input Modules						
00	-15 mV to +15 mV	Input Range	+15.0 mV	-15.0 mV	0.00030518	0
		Decimal Units	+32767	-32768		
		2's Complement Hexadecimal Units	7FFF	8000		
01	-50 mV to +50 mV	Input Range	+50.0 mV	-50.0 mV	0.001525902	0
		Decimal Units	+32767	-32768		
		2's Complement Hexadecimal Units	7FFF	8000		
02	-100 mV to +100 mV	Input Range	+100.0 mV	-100.0 mV	0.003051804	0
		Decimal Units	+32767	-32768		
		2's Complement Hexadecimal Units	7FFF	8000		
03	-500 mV to +500 mV	Input Range	+500.0 mV	-500.0 mV	0.015259022	0
		Decimal Units	+32767	-32768		
		2's Complement Hexadecimal Units	7FFF	8000		
04	-1 V to +1V	Input Range	+1.0 V	-1.0 V	0.000030518	0
		Decimal Units	+32767	-32768		
		2's Complement Hexadecimal Units	7FFF	8000		
05	-2.5 V to +2.5 V	Input Range	+2.5V	-2.5V	0.025	0
		Decimal Units	+32767	-32768		
		2's Complement Hexadecimal Units	7FFF	8000		
06*1	-20 mA to +20 mA	Input Range	+20.0 mA	-20.0 mA	0.00061036	0
		Decimal Units	+32767	-32768		

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Type Code	Type Definitions	Data Format	Max. Value	Min. Value	Gain	Offset
	(With 125 ohms resistor)	2's Complement Hexadecimal Units	7FFF	8000		
07*2	+4 mA to +20 mA	Input Range	+20.0 mA	+4.0 mA	0.000488296	+4
		Decimal Units	+65535	+0		
		2's Complement Hexadecimal Units	FFFF	0000		
08	-10 V to +10 V	Input Range	+10.0 V	-10.0 V	0.00030518	0
		Decimal Units	+32767	-32768		
		2's Complement Hexadecimal Units	7FFF	8000		
09	-5 V to +5 V	Input Range	+5.0 V	-5.0 V	0.00015259	0
		Decimal Units	+32767	-32768		
		2's Complement Hexadecimal Units	7FFF	8000		
0A	-1 V to +1V	Input Range	+1.0 V	-1.0 V	0.000030518	0
		Decimal Units	+32767	-32768		
		2's Complement Hexadecimal Units	7FFF	8000		
0B	-500 mV to +500 mV	Input Range	+500.0 mV	-500.0 mV	0.015259022	0
		Decimal Units	+32767	-32768		
		2's Complement Hexadecimal Units	7FFF	8000		
0C	-150 mV to +150 mV	Input Range	+150.0 mV	-150.0 mV	0.004577706	0
		Decimal Units	+32767	-32768		
		2's Complement Hexadecimal Units	7FFF	8000		
0D*3	-20 mA to +20 mA (with 125 ohms resistor)	Input Range	+20.0 mA	-20.0 mA	0.00061036	0
		Decimal Units	+32767	-32768		
		2's Complement Hexadecimal Units	7FFF	8000		

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Type Code	Type Definitions	Data Format	Max. Value	Min. Value	Gain	Offset
1A[*2]	+0 mA to +20 mA	Input Range	+20.0 mA	+0.0 mA	0.00030518	0
		Decimal Units	+65535	+0		
		2's Complement Hexadecimal Units	FFFF	0000		
1B	-150 V to +150 V	Input Range	+150.0 V	-150.0 V	0.0045777	0
		Decimal Units	+32767	-32768		
		2's Complement Hexadecimal Units	7FFF	8000		
1C	-50 V to +50 V	Input Range	+50.0 V	-50.0 V	0.0015259	0
		Decimal Units	+32767	-32768		
		2's Complement Hexadecimal Units	7FFF	8000		
Digital Input/Output, Counter, Frequency, Encoder Modules						
40	Digital Input/ Output	N/A	N/A	N/A	N/A	N/A
50	Counter Mode	N/A	N/A	N/A	N/A	N/A
51	Frequency Mode	N/A	N/A	N/A	N/A	N/A
54	Up/Down Counter Mode	N/A	N/A	N/A	N/A	N/A
55	Pulse Mode	N/A	N/A	N/A	N/A	N/A
56	AB Phase Mode	N/A	N/A	N/A	N/A	N/A
Analog Output Modules						
0, 30	+0 mA to +20 mA	Output Range	+20.0 mA	+0.0 mA	0.00061037	0
		Decimal Units	+32767	+0		
		2's Complement Hexadecimal Units	7FFF	0000		

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Type Code	Type Definitions	Data Format	Max. Value	Min. Value	Gain	Offset
		Gain^{-1} = 1638.35				
1, 31	+4 mA to +20 mA	Output Range	+20.0 mA	+4.0 mA	0.000488296	+4
		Decimal Units	+32767	+0		
		2's Complement Hexadecimal Units	7FFF	0000		
		Gain^{-1} = 2047.9375				
2, 32	+0 V to +10 V	Output Range	+10.0 V	+0.0 V	0.000305185	0
		Decimal Units	+32767	+0		
		2's Complement Hexadecimal Units	7FFF	0000		
		Gain^{-1} = 3276.7				
3, 33	-10 V to +10 V	Output Range	+10.0 V	-10.0 V	0.00030518	0
		Decimal Units	+32767	-32768		
		2's Complement Hexadecimal Units	7FFF	8000		
		Gain^{-1} = 3276.75				
4, 34	+0 V to +5 V	Output Range	+5.0 V	+0.0 V	0.00015259	0
		Decimal Units	+32767	0		
		2's Complement Hexadecimal Units	7FFF	0000		
		Gain^{-1} = 6553.4				
5, 35	-5 V to +5 V	Output Range	+5.0 V	-5.0 V	0.00015259	0
		Decimal Units	+32767	-32768		
		2's Complement Hexadecimal Units	7FFF	8000		
		Gain^{-1} = 6553.4				
6, 36	+0 V to +20 V	Output Range	+20.0 V	+0.0 V	0.00061037	0
		Decimal Units	+32767	0		
		2's Complement Hexadecimal Units	7FFF	0000		

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Type Code	Type Definitions	Data Format	Max. Value	Min. Value	Gain	Offset
		$Gain^{-1}$ = 1638.35				

Notes

*1: When I-87018 and I-87018R are connecting to a current source set to the 06 type code, an optional external 125 Ohms resistor is required.

*2: I-87017RC has built-in 125 Ohms resistors for each channel. When connecting to a current source, no add any external resistors required.

*3: When I-87017 and I-87017R are connecting to a current source set to 0D type code, an optional external 125 Ohms resistor is required. On the other hand, I-87017RC has built-in 125 Ohms resistors for each channel, so require no external resistors.

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1.2. Thermocouple Type Definitions

Type Code	Thermocouple Type	Data Format	Max. Value	Min. Value	Gain	Offset
0E	J Type	Input Range (Celsius)	+760.0	-210.0	0.023194089	0
		Decimal Units	+32767	-9054		
		2's Complement Hexadecimal Units	7FFF	DCA2		
0F	K Type	Input Range (Celsius)	+1372.0	-270.0	0.0418717327	0
		Engineer Unit	+32767	-6448		
		2's Complement HEX	7FFF	E6D0		
10	T Type	Input Range (Celsius)	+400.0	-270.0	0.0122073426	0
		Decimal Units	+32767	-22118		
		2's Complement Hexadecimal Units	7FFF	A99A		
11	E Type	Input Range (Celsius)	+1000.0	-270.0	0.030518575	0
		Decimal Units	+32767	-8847		
		2's Complement Hexadecimal Units	7FFF	DD71		
12	R Type	Input Range (Celsius)	+1768.0	+0.0	0.0539567247	0
		Decimal Units	+32767	+0		
		2's Complement Hexadecimal Units	7FFF	0000		
13	S Type	Input Range (Celsius)	+1768.0	+0.0	0.0539567247	0
		Decimal Units	+32767	+0		
		2's Complement Hexadecimal Units	7FFF	0000		

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Type Code	Thermocouple Type	Data Format	Max. Value	Min. Value	Gain	Offset
14	B Type	Input Range (Celsius)	+1820.0	+0.0	0.0555436872	0
		Decimal Units	+32767	+0		
		2's Complement Hexadecimal Units	7FFF	0000		
15	N Type	Input Range (Celsius)	+1300.0	-270.0	0.0396745173	0
		Decimal Units	+32767	-6805		
		2's Complement Hexadecimal Units	7FFF	E56B		
16	C Type	Input Range (Celsius)	+2320.0	+0.0	0.0708029419	0
		Decimal Units	+32767	+0		
		2's Complement Hexadecimal Units	7FFF	0000		
17	L Type	Input Range (Celsius)	+800.0	-200.0	0.0244146585	0
		Decimal Units	+32767	-8192		
		2's Complement Hexadecimal Units	7FFF	E000		
18	M Type	Input Range (Celsius)	+100.0	-200.0	0.0061035156	0
		Decimal Units	+16384	-32768		
		2's Complement Hexadecimal Units	4000	8000		
19	L Type DIN43710	Input Range (Celsius)	+900.0	-200.0	0.0274670395	0
		Decimal Units	+32767	-7281		
		2's Complement Hexadecimal Units	7FFF	E38F		

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1.3. RTD (Resistance Temperature Detector) Type Definitions

Type Code	RTD Type	Data Format	Max. Value	Min. Value	Gain	Offset
20	Platinum 100 a = 0.00385 -100°C to 100°C	Input Range (Celsius)	+100.0	-100.0	0.0030518043	0
		Decimal Units	+32767	-32768		
		2's Complement Hexadecimal Units	7FFF	8000		
		Ohm	+138.5	+60.25		
21	Platinum 100 a = 0.00385 0°C to 100°C	Input Range (Celsius)	+100.0	+0.0	0.0030518509	0
		Decimal Units	+32767	+0		
		2's Complement Hexadecimal Units	7FFF	0000		
		Ohm	+138.5	+100.0		
22	Platinum 100 a = 0.00385 0°C to 200°C	Input Range (Celsius)	+200.0	+0.0	0.0061037018	0
		Decimal Units	+32767	+0		
		2's Complement Hexadecimal Units	7FFF	0000		
		Ohm	+175.84	+100.0		
23	Platinum 100 a = 0.00385 0°C to 600°C	Input Range (Celsius)	+600.0	+0.0	0.0183111056	0
		Decimal Units	+32767	+0		
		2's Complement Hexadecimal Units	7FFF	0000		
		Ohm	+313.59	+100.0		
24	Platinum 100 a = 0.003916 -100°C to 100°C	Input Range (Celsius)	+100.0	-100.0	0.0030518043	0
		Decimal Units	+32767	-32768		
		2's Complement Hexadecimal Units	7FFF	8000		
		Ohm	+139.16	+59.58		

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Type Code	RTD Type	Data Format	Max. Value	Min. Value	Gain	Offset
25	Platinum 100 a = 0.003916 0°C to 100°C	Input Range (Celsius)	+100.0	+0.0	0.0030518509	0
		Decimal Units	+32767	+0		
		2's Complement Hexadecimal Units	7FFF	0000		
		Ohm	+139.16	+100.0		
26	Platinum 100 a = 0.003916 0°C to 200°C	Input Range (Celsius)	+200.0	+0.0	0.0061037018	0
		Decimal Units	+32767	+0		
		2's Complement Hexadecimal Units	7FFF	0000		
		Ohm	+177.13	+100.0		
27	Platinum 100 a = 0.003916 0°C to 600°C	Input Range (Celsius)	+600.0	+0.0	0.01831110568	0
		Decimal Units	+32767	+0		
		2's Complement Hexadecimal Units	7FFF	0000		
		Ohm	+317.28	+100.0		
28	Nickel 120 -80°C to 100°C	Input Range (Celsius)	+100.0	-80.0	0.0030518302	0
		Decimal Units	+32767	-26214		
		2's Complement Hexadecimal Units	7FFF	999A		
		Ohm	+200.64	+120.6		
29	Nickel 120 0°C to 100°C	Input Range (Celsius)	+100.0	+0.0	0.0030518509	0
		Decimal Units	+32767	+0		
		2's Complement Hexadecimal Units	7FFF	0000		
		Ohm	+200.64	+120.6		
2A	Platinum	Input Range	+600.0	-200.0	0.0183112453	0

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Type Code	RTD Type	Data Format	Max. Value	Min. Value	Gain	Offset
	1000 a =0.00385 -200°C to 600°C	(Celsius)				
		Decimal Units	+32767	-10922		
		2's Complement Hexadecimal Units	7FFF	D556		
		Ohm	+3137.1	+185.2		
2B*1	Cu 100 a =0.00421 -20°C to 150°C	Input Range (Celsius)	+150.0	-20.0	0.0045777	0
		Decimal Units	+32767	-4369		
		2's Complement Hexadecimal Units	7FFF	EEEF		
		Ohm	+163.17	+91.56		
2C*1	Cu 100 a =0.00421 0°C to 200°C	Input Range (Celsius)	+200.0	+0.0	0.0061037	0
		Decimal Units	+32767	+0		
		2's Complement Hexadecimal Units	7FFF	0000		
		Ohm	+167.75	+90.34		
2D*1	Cu 1000 a =0.00421 -20°C to 150°C	Input Range (Celsius)	+150.0	-20.0	0.0045777	0
		Decimal Units	+32767	-4369		
		2's Complement Hexadecimal Units	7FFF	EEEF		
		Ohm	+1631.7	+915.6		
2E*2	Pt 100 a =0.00385 -200°C to 200°C	Input Range (Celsius)	+200.0	-200.0	0.0061036	0
		Decimal Units	+32767	-32768		
		2's Complement Hexadecimal Units	7FFF	8000		
		Ohm	+175.84	+18.49		
2F*2	Pt 100 a	Input Range (Celsius)	+200.0	-200.0	0.0061036	0

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Type Code	RTD Type	Data Format	Max. Value	Min. Value	Gain	Offset
	=0.003916 -200°C to 200°C	Decimal Units	+32767	-32768		
		2's Complement Hexadecimal Units	7FFF	8000		
		Ohm	+177.14	+17.14		
80*2	Pt 100 a =0.00385 -200°C to 600°C	Input Range (Celsius)	+600.0	-200.0	0.018311	0
		Decimal Units	+32767	-10922		
		2's Complement Hexadecimal Units	7FFF	D556		
		Ohm	+313.59	+18.49		
81*2	Pt 100 a =0.003916 -200°C to 600°C	Input Range (Celsius)	+600.0	-200.0	0.018311	0
		Decimal Units	+32767	-10922		
		2's Complement Hexadecimal Units	7FFF	D556		
		Ohm	+317.28	+17.14		

Notes

*1: Type code 2B, 2C and 2D are only available with I-87015.

*2: Type code 2E, 2F, 80 and 81 are only available with the I-87015 firmware version A1.10 and later, I-87013 firmware version B1.3 and later.

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1.4. Thermistor Type Definitions

Type Code	Thermistor Type	Data Format	Max. Value	Min. Value	Gain	Offset
60	Precon ST-A3 -30 to 240 degree Fahrenheit	Input Range (Fahrenheit)	+240.0	-30.0	0.0073244	0
		Decimal Units	+32767	-4096		
		2's Complement Hexadecimal Units	7FFF	F000		
		Ohm	+539.4	+173600.0		
61	Type U Fenwell -50 to 150 degree Celsius	Input Range (Celsius)	+150.0	-50.0	0.004577	0
		Decimal Units	+32767	-10922		
		2's Complement Hexadecimal Units	7FFF	D556		
		Ohm	+37.2	+134020.0		
62	Type U Fenwell 0 to 150 degree Celsius	Input Range (Celsius)	+150.0	+0.0	0.004577	0
		Decimal Units	+32767	+0		
		2's Complement Hexadecimal Units	7FFF	0000		
		Ohm	+37.2	+6530.0		
63	YSI L Mix 100	Input Range (Celsius)	+100.0	-80.0	0.0030518	0
		Decimal Units	+32767	-26214		
		2's Complement Hexadecimal Units	7FFF	999A		
		Ohm	+14.3	+14470.0		
64	YSI L Mix 300	Input Range	+100.0	-80.0	0.0030518	0
		Decimal Units	+32767	-26214		
		2's Complement Hexadecimal Units	7FFF	999A		
		Ohm	+35.8	+67660.0		

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Type Code	Thermistor Type	Data Format	Max. Value	Min. Value	Gain	Offset
65	YSI L Mix 1000	Input Range (Celsius)	+100.0	-70.0	0.00305	0
		Decimal Units	+32767	-22937		
		2's Complement Hexadecimal Units	7FFF	A667		
		Ohm	+106.4	+132600.0		
66	YSI B Mix 2252	Input Range (Celsius)	+150.0	-50.0	0.004577	0
		Decimal Units	+32767	-10922		
		2's Complement Hexadecimal Units	7FFF	D556		
		Ohm	+41.8	+151000.0		
67	YSI B Mix 3000	Input Range (Celsius)	+150.0	-40.0	0.004577	0
		Decimal Units	+32767	-8738		
		2's Complement Hexadecimal Units	7FFF	DDDE		
		Ohm	+55.6	+101000.0		
68	YSI B Mix 5000	Input Range (Celsius)	+150.0	-40.0	0.004577	0
		Decimal Units	+32767	-8738		
		2's Complement Hexadecimal Units	7FFF	DDDE		
		Ohm	+92.7	+168300.0		
69	YSI B Mix 6000	Input Range (Celsius)	+150.0	-30.0	0.004577	0
		Decimal Units	+32767	-6553		
		2's Complement Hexadecimal Units	7FFF	E667		
		Ohm	+111.5	+106200.0		
6A	YSI B Mix	Input Range	+150.0	-30.0	0.004577	0

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Type Code	Thermistor Type	Data Format	Max. Value	Min. Value	Gain	Offset
	10K	(Celsius)				
		Decimal Units	+32767	-6553		
		2's Complement Hexadecimal Units	7FFF	E667		
		Ohm	+185.9	+177000.0		
6B	YSI H Mix 10K	Input Range (Celsius)	+150.0	-30.0	0.004577	0
		Decimal Units	+32767	-6553		
		2's Complement Hexadecimal Units	7FFF	E667		
		Ohm	+237.0	+135200.0		
6C	YSI H Mix 30K	Input Range (Celsius)	+200.0	-10.0	0.0061037	0
		Decimal Units	+32767	-1638		
		2's Complement Hexadecimal Units	7FFF	F99A		
		Ohm	+186.7	+158000.0		
70-77	User-defined -50 to 150 degree Celsius	Input Range (Celsius)	+150.0	-50.0	0.004577	0
		Decimal Units	+32767	-10922		
		2's Complement Hexadecimal Units	7FFF	D556		
		Ohm	+0.0	+0.0		

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2. 8K Modules

Type Code	Type Definitions	Data Format	Max. Value	Min. Value	Gain	Offset
05	-2.5 V to +2.5 V	Input Range	+2.5 V	-2.5 V	0.000076295	0
		Decimal Units	+32767	-32768		
		2's Complement Hexadecimal Units	7FFF	8000		
06	-20 mV to +20 mV	Input Range	+20.0 mV	-20.0 mV	0.00061036	0
		Decimal Units	+32767	-32768		
		2's Complement Hexadecimal Units	7FFF	8000		
07	-1.25 V to +1.25 V	Input Range	+1.25 V	-1.25 V	0.000038147	0
		Decimal Units	+32767	-32768		
		2's Complement Hexadecimal Units	7FFF	8000		
08	-10 V to +10 V	Input Range	+10.0 V	-10.0 V	0.00030518	0
		Decimal Units	+32767	-32768		
		2's Complement Hexadecimal Units	7FFF	8000		
09	-5 V to +5 V	Input Range	+5.0 V	-5.0 V	0.00015259	0
		Decimal Units	+32767	-32768		
		2's Complement Hexadecimal Units	7FFF	8000		
30	+0 mA to +20 mA	Output Range	+20.0 mA	+0.0 mA	0.00061037	0
		Decimal Units	+32767	+0		
		2's Complement Hexadecimal Units	7FFF	0000		
		$Gain^{-1}$ = 1638.35				
33	-10 V to +10 V	Output Range	+10.0 V	-10.0 V	0.00030518	0
		Decimal Units	+32767	-32768		
		2's Complement	7FFF	8000		

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Type Code	Type Definitions	Data Format	Max. Value	Min. Value	Gain	Offset
		Hexadecimal Units				
		$Gain^{-1}$ = 3276.75				
80	Mode 0: Pulse/ Direction Counter	Decimal Units	+2147483647	-2147483648	1	0
		2's Complement Hexadecimal Units	7FFFFFFF	80000000		
	Mode 1: Up/Down Counter	Decimal Units	+2147483647	-2147483648	1	0
		2's Complement Hexadecimal Units	7FFFFFFF	80000000		
	Mode 2: Frequency	Decimal Units	450000	0	1	0
		2's Complement Hexadecimal Units	6DDD0	00000000		
	Mode 3: Up Counter	Decimal Units	+4294967295	0	1	0
		2's Complement Hexadecimal Units	FFFFFFFF	00000000		

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